ORDNANCE

LAND · SEA · AIR

Atomic Gunfire

SEPTEMBER-OCTOBER 1956

HOW LIFT TRUCKS STAY DEPENDABLE:
Timken® bearings keep gears aligned despite constant start-stop wear & tear

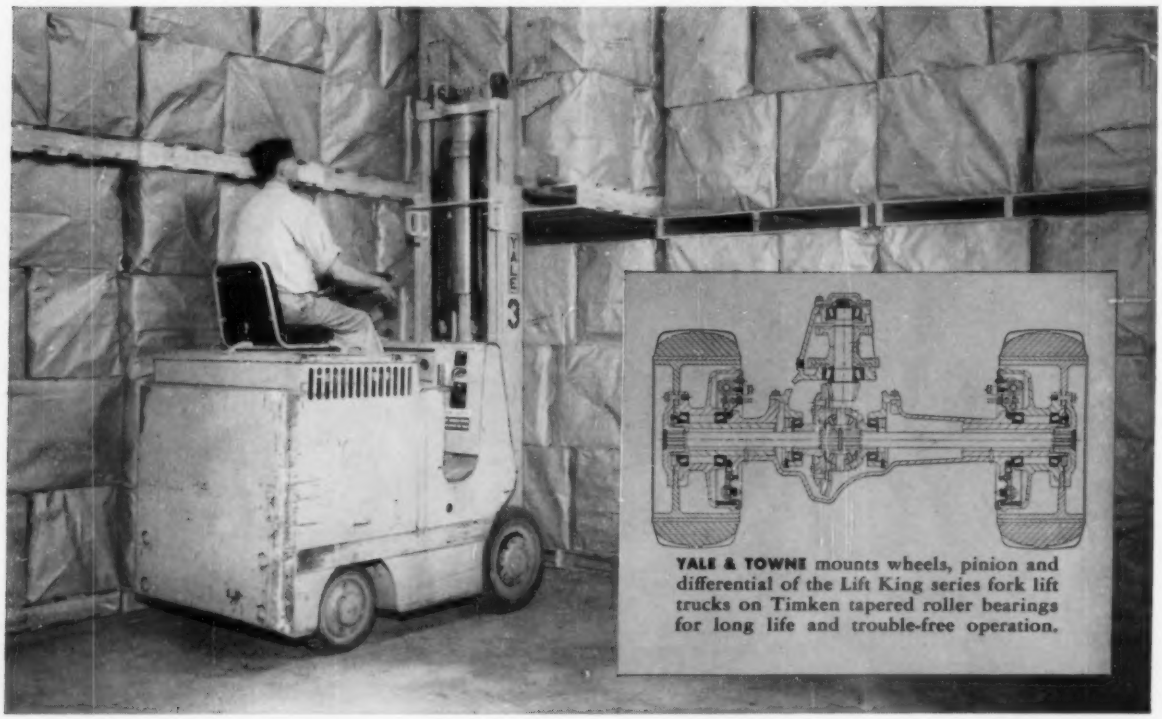
EVERY time a lift truck goes forward, stops, backs up, or turns right or left, there's a heavy load put on the gears and gear mountings. To maintain trouble-free performance through all this wear & tear, Yale & Towne mounts wheels, differential and pinion gears of its electric fork lift truck on Timken® tapered roller bearings.

Timken bearings keep the gears in accurate alignment despite the heavy, changing loads. In Timken bearings the load is carried on full lines of contact between races and rollers which gives them inherently high capacity. The gears mesh properly and this means longer gear life and less maintenance.

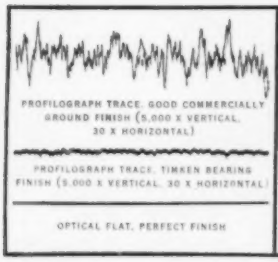
The big bevel gears in the differential exert heavy thrust loads as well as radial loads. But no extra thrust devices are needed because the taper enables Timken bearings to take any combination of radial and thrust loads. This makes for a simpler, more trouble-free design.

Timken bearings make all kinds of machinery run better and last longer. Designed by geometric law for true rolling, and made with great accuracy to conform to the design, Timken bearings practically eliminate friction. Always look for the trade-mark "Timken" on the bearings in the machines you buy or build. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



YALE & TOWNE mounts wheels, pinion and differential of the Lift King series fork lift trucks on Timken tapered roller bearings for long life and trouble-free operation.


PROFILOGRAPH TRACE, GOOD COMMERCIALLY GROUND FINISH (5,000 X VERTICAL, 30 X HORIZONTAL)
PROFILOGRAPH TRACE, TIMKEN BEARING FINISH (5,000 X VERTICAL, 30 X HORIZONTAL)
OPTICAL FLAT, PERFECT FINISH

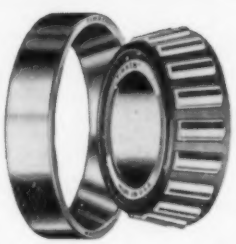
SMOOTH TO MILLIONTHS OF AN INCH

Surface finish of high quality Timken bearing rollers and races is so smooth that it takes a profilograph to measure its smoothness. This instrument measures surface variations to a millionth of an inch, as shown at the left.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ◯ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ▯ AND THRUST ⟷ LOADS OR ANY COMBINATION ✳

ORDNANCE

LAND · SEA · AIR

The Magazine of Scientific and Industrial Preparedness Now in Its 37th Year

VOL. XLI | SEPTEMBER-OCTOBER 1956 | NO. 218

The Cover.—*The fireball from the first atomic shell fired from the Army's 280-mm. gun is shown bursting over Frenchman's Flat, Nev. The event ushered in a new era in the strategy and tactics of modern artillery.*

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New multibarreled cannon gives us unrivaled aërial firepower

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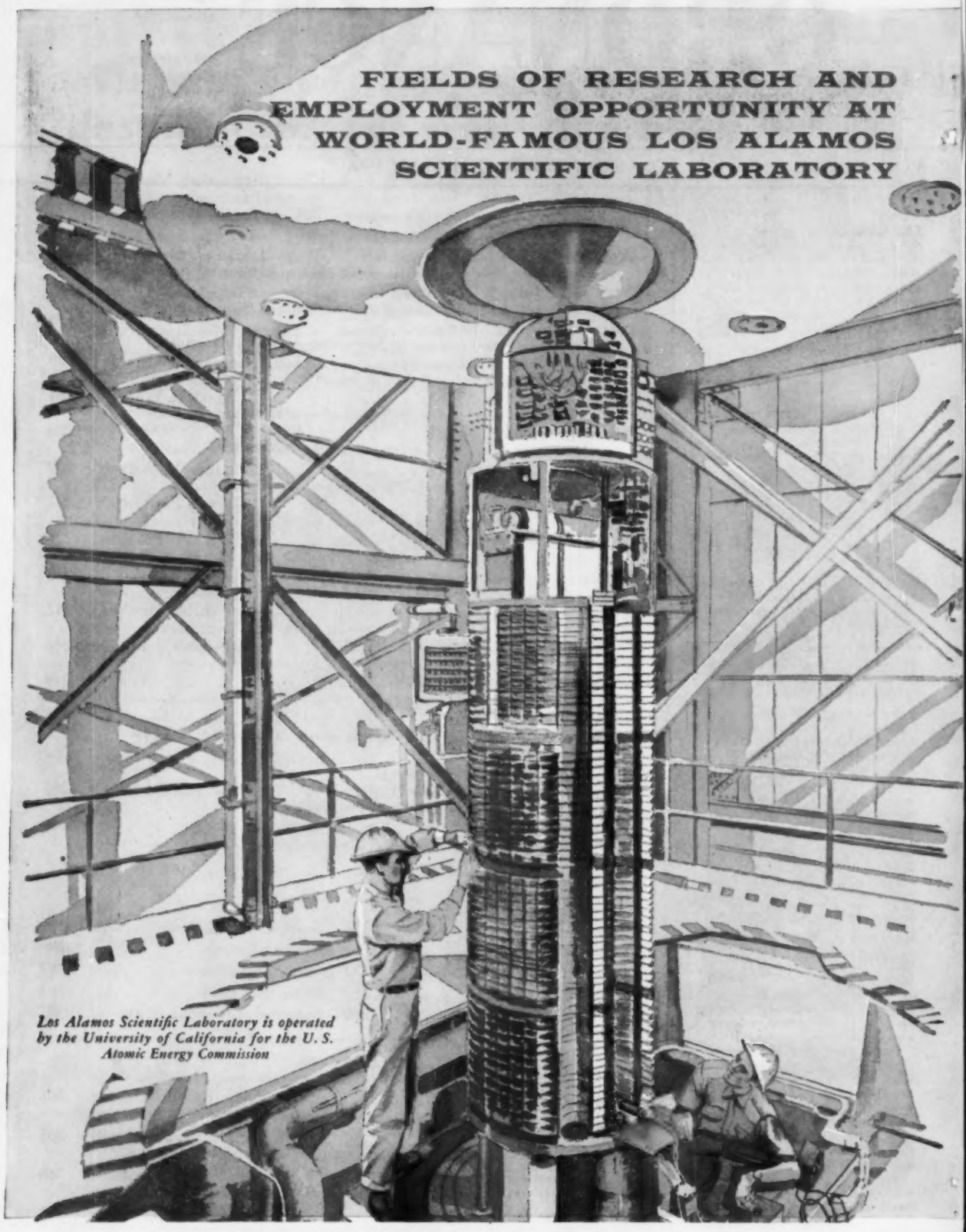
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Los Alamos Scientific Laboratory is operated
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Atomic Energy Commission

Theoretical Physics and Mathematics

In the field of theoretical physics, the Laboratory carries on studies of nuclear theory, equations of state, mathematical analysis methods, hydrodynamics problems and various aspects of applied mathematics. The Theoretical Division is also concerned with the conceptual design of nuclear weapons, and supports many non-weapons activities such as the nuclear reactor and propulsion programs. The equipment used includes the Los Alamos-developed Maniac, the Maniac II, two IBM 704's and an IBM 701.

Experimental Nuclear Physics

Much of the work in experimental physics is concerned with nuclear properties of various materials. Fundamental studies are made of nuclear forces, neutron and charged-particle reactions and cross sections. Experimentation in controlled thermonuclear reactions is assuming increasing importance. Among the facilities available are three Van de Graaffs, two Cockcroft-Walton machines and a variable energy cyclotron.

Electronics and Instrumentation

The Laboratory is engaged in the design and development of nuclear physics research instruments, scintillation counters, fast pulse amplifiers, multi-channel analyzers, fast oscilloscopes, radiation detection instruments, electronic controls and control systems, and high-speed cameras which operate at 15 million frames per second. Electronics specialists also assist in the design of digital computers and of instruments for studying nuclear and thermonuclear detonations.

Nuclear Reactor Research

In connection with the peacetime applications of nuclear energy, the Laboratory is currently developing several advanced power reactors of unusual design. In addition, two research reactors are available for experimental studies. The remotely controlled critical assembly machines, known as Topsy, Godiva and Jezebel, constitute neutron research tools of a unique character.

Nuclear Propulsion

The Laboratory is actively engaged in the application of nuclear energy to the new and challenging field of self-propelled mobile reactors. There are studies in progress relative to engine design, heat transfer, controls and instrumentation.

Chemistry

Research in chemistry is devoted largely to inorganic and physical studies, especially of materials such as uranium, plutonium, deuterium and tritium used in nuclear energy systems. Radiochemical methods are applied in various investigations. Much work is being done on reaction kinetics, the effects of radiation on chemical reactions, complex ion formation and the determination of heats of combustion and solution. Extensive analytical studies include the use of a great variety of instruments, as well as the techniques of microanalysis.

Metallurgy and Metallurgical Engineering

Research activity and development in this field includes investigation of the metallurgical properties of materials used in nuclear energy systems; studies of extremely refractory substances, ceramics, cermets and plastics; the behavior of materials under extremely high temperatures and high pressures; studies of the properties of plutonium and its alloys, with increasing reference to their use in reactors, and of uranium and its alloys; development of fabrication techniques for various metals and alloys; and the high temperature properties of refractory metals tungsten, molybdenum, columbium, etc.

Weapons Physics, Design and Testing

Still the nation's principal institution for nuclear and thermonuclear weapons research, the Laboratory takes nuclear weapons from the concept stage to proved performance as determined by field tests. Activities in weapons research and development include the mechanics and dynamics of initiating a nuclear energy release; the behavior of supercritical systems; the testing of nuclear devices and weapons assemblies in Nevada and in the Pacific; engineering design of tests and prototypes of nuclear systems; and the design and development of nuclear weapons components and the techniques for their manufacture.

Explosives Research and Development

Work in this field includes study of fabrication, storage and stability problems of explosives; making and evaluating novel organic chemical compounds of possible use as explosives; mechanics and dynamics of explosive phenomena; and physical and chemical properties of explosive material using mass spectrometer, infra-red spectrometer, X-ray equipment and other analytical techniques. High explosives are employed in research on equations of state and shock wave phenomena.

Mechanical Engineering

Design and development work is carried on in connection with weapons design, field test facilities, the power reactor and propulsion programs, servo-mechanisms and remote control systems. High explosives systems are designed and manufactured. Other types of work are estimating, cost analysis and liaison between architectural engineers and contractors.

Chemical Engineering

Chemical engineering work includes studies of heat transfer, fluid flow, solvent extraction, evaporation, distillation and systems at extreme temperatures and pressures. Problems supporting inorganic and physical chemistry research projects are also undertaken. Other activities are the remote control handling of radioactive materials and corrosion and erosion studies.

Electrical Engineering

Much effort is devoted to the design of induction heating systems for study of alloys at extremely high temperatures; of DC power supplies at currents up to 100,000 amperes; of servomechanism controls for nuclear reactors; and of high magnetic field systems. Work is done in planning, building and installing power distribution systems and their controls.

The Laboratory now has staff openings for technically qualified people interested in these fields of research and development. For additional information address your inquiry to

Director of Personnel
Division 1118

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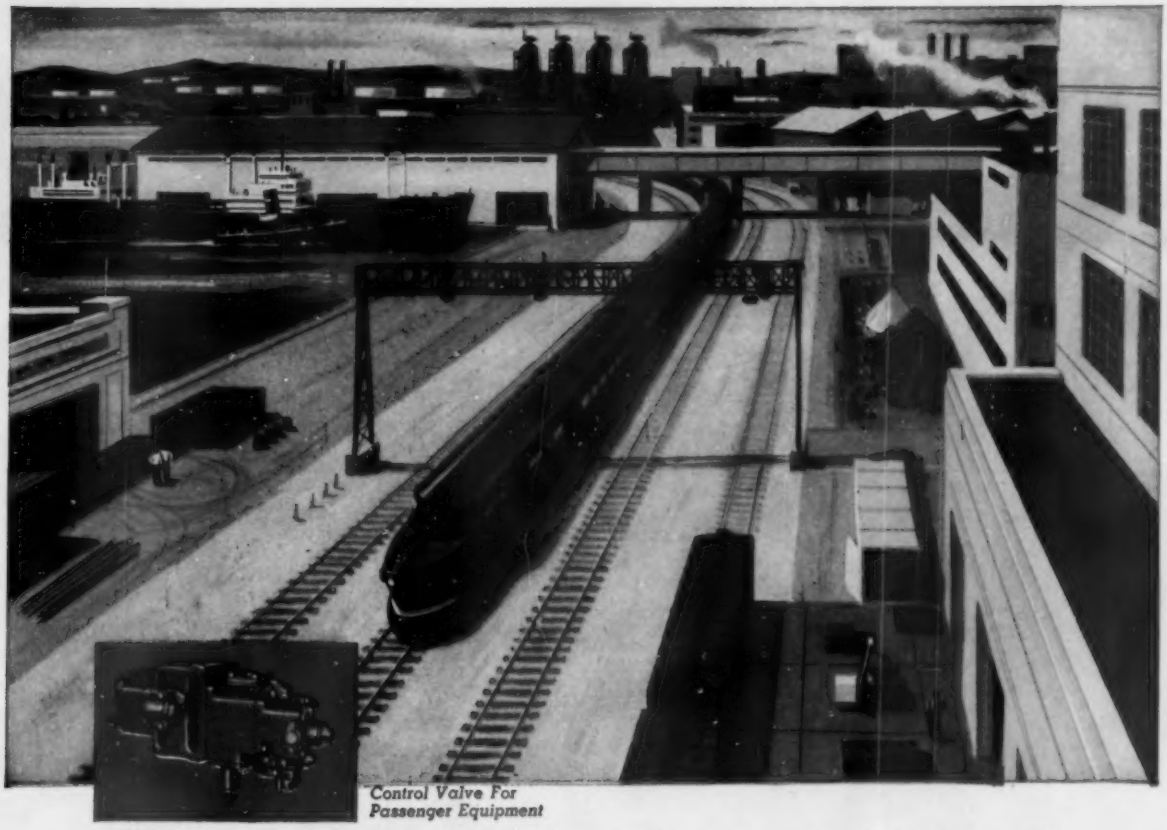

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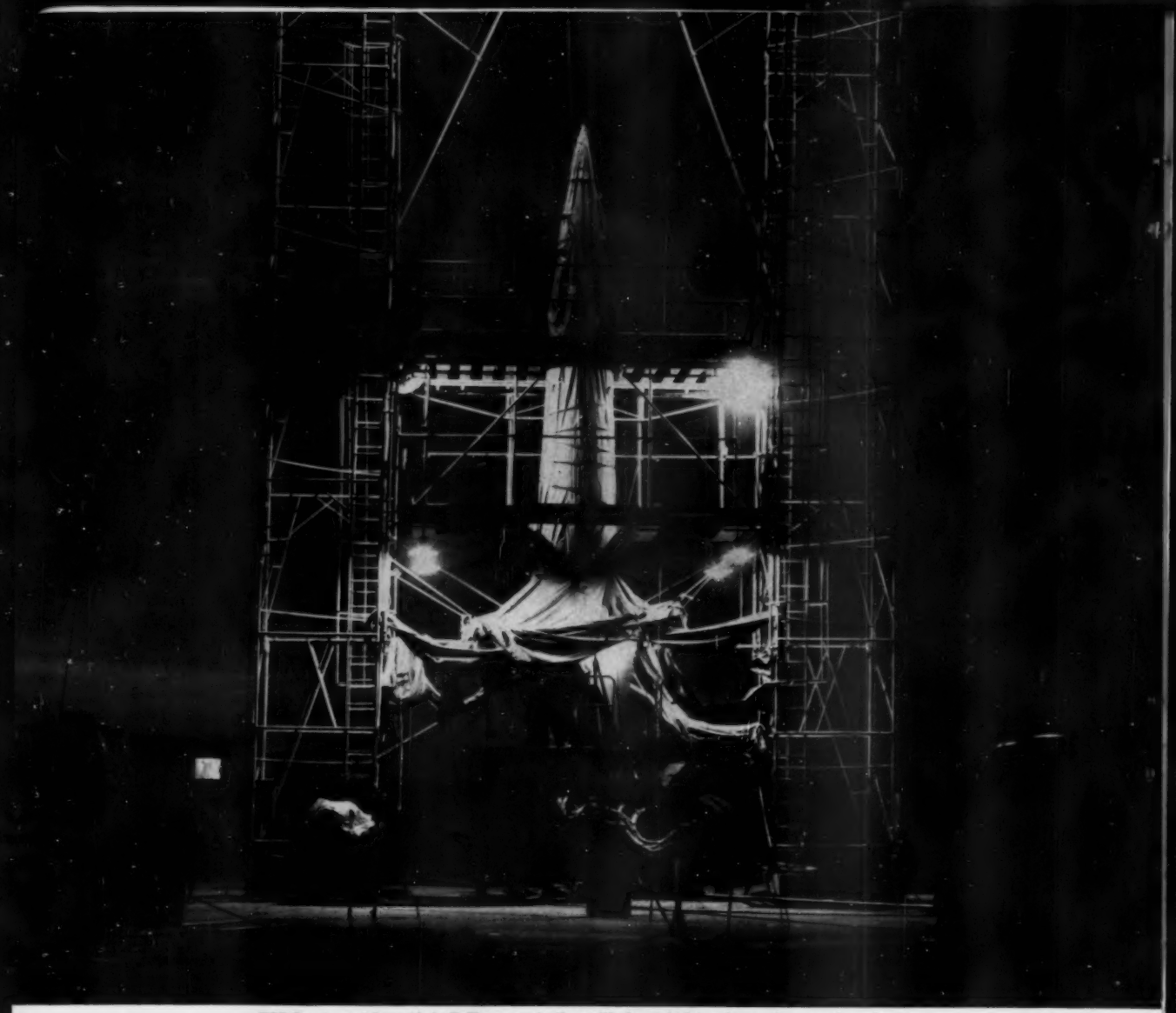

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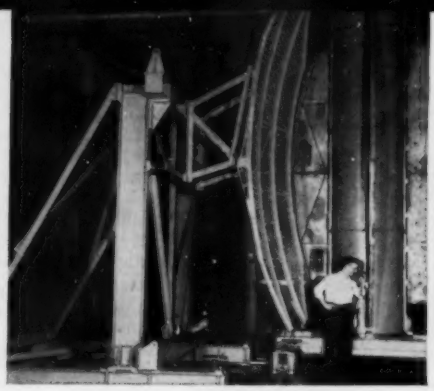

COMMUNICATIONS

HYPERSONICS

At General Electric, George F. Metcalf reports:

New Department to Help Solve Complex Defense System Problems

GEORGE F. METCALF, is General Manager of General Electric's new Special Defense Projects Department, located in Philadelphia, Pa. Mr. Metcalf has had extensive management experience in the military electronics field, both in Government Service and in the General Electric Company's Electronic Division.

Realizing the increased complexity of some of the nation's current defense system problems, General Electric has formed the Special Defense Projects Department. The new department will act as a Company focal point for large, highly complex missile projects. Headquarters for the new department will be located near Philadelphia, Pa. This new department has responsibility for large defense systems that require the combined research, development, and manufacturing resources of many of General Electric's operating departments and laboratories.

Manned by a highly skilled engineering and development staff, the Special Defense Projects Department relies upon General Electric operating departments and laboratories for many specialized phases of its defense projects.

The Special Defense Projects Department is making significant contributions to America's defense program by focusing the wide range of specialized talents of General Electric on highly complex defense system problems. Section 224-4, General Electric Co., Schenectady 5, N.Y.

ENGINEERS: G.E.'s Special Defense Projects Department is currently expanding its staff of highly skilled engineers and scientists. If you have a background of successful, creative engineering send your qualifications to: Mr. George Metcalf, 3198 Chestnut St., Special Defense Projects Department, General Electric Company, Philadelphia, Pa.

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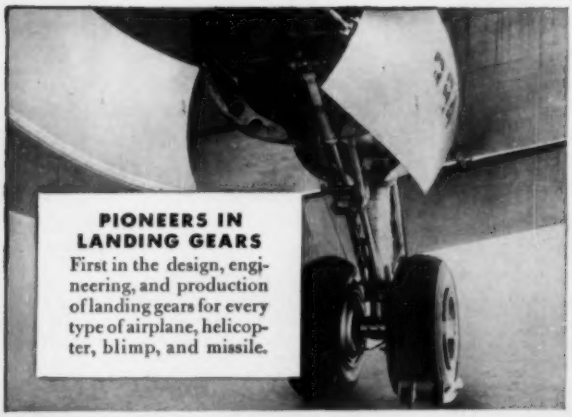

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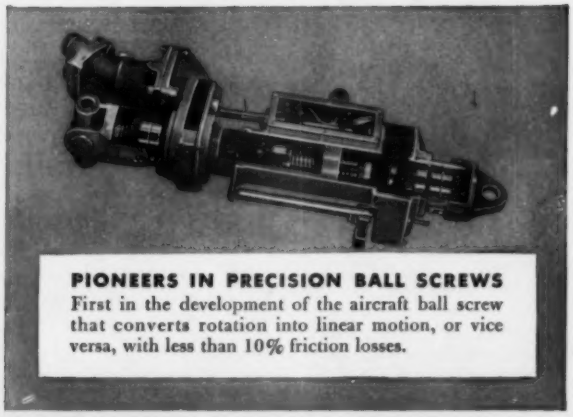

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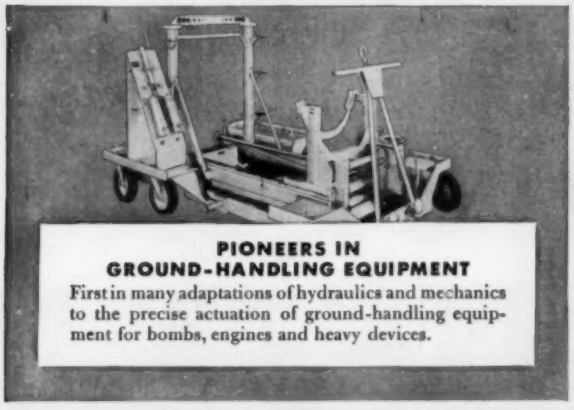

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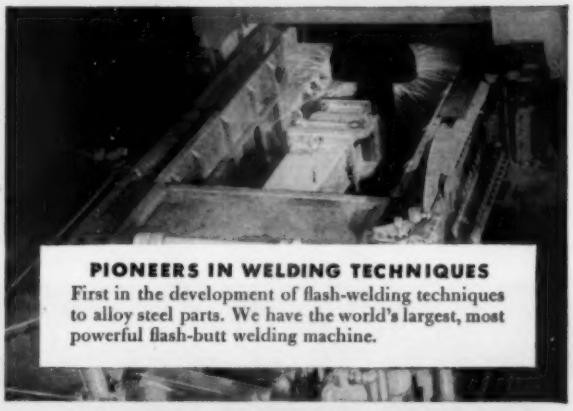

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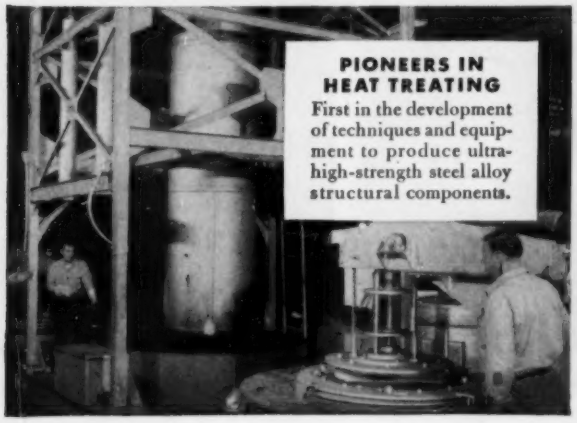

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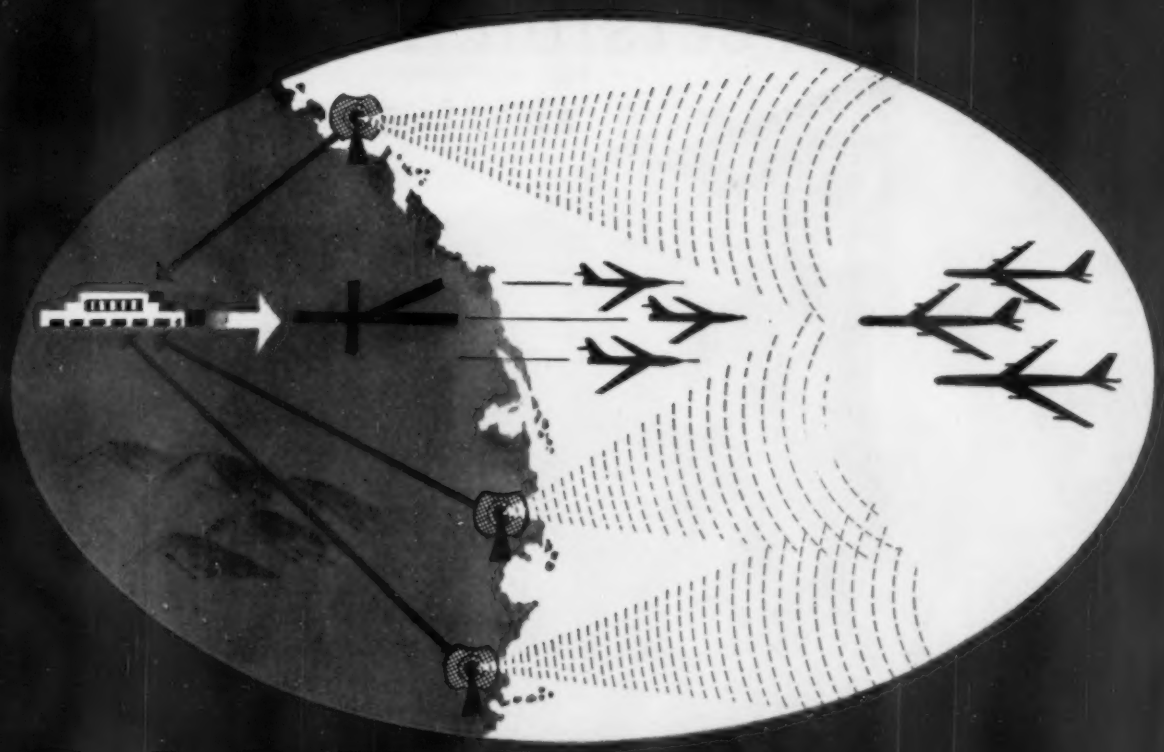

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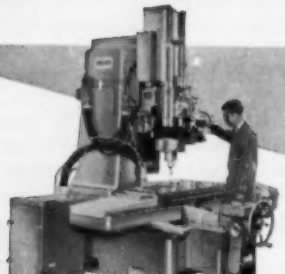

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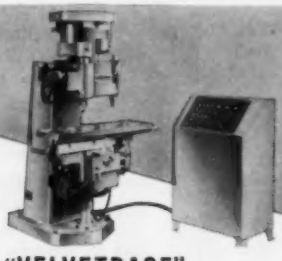

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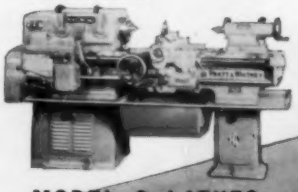

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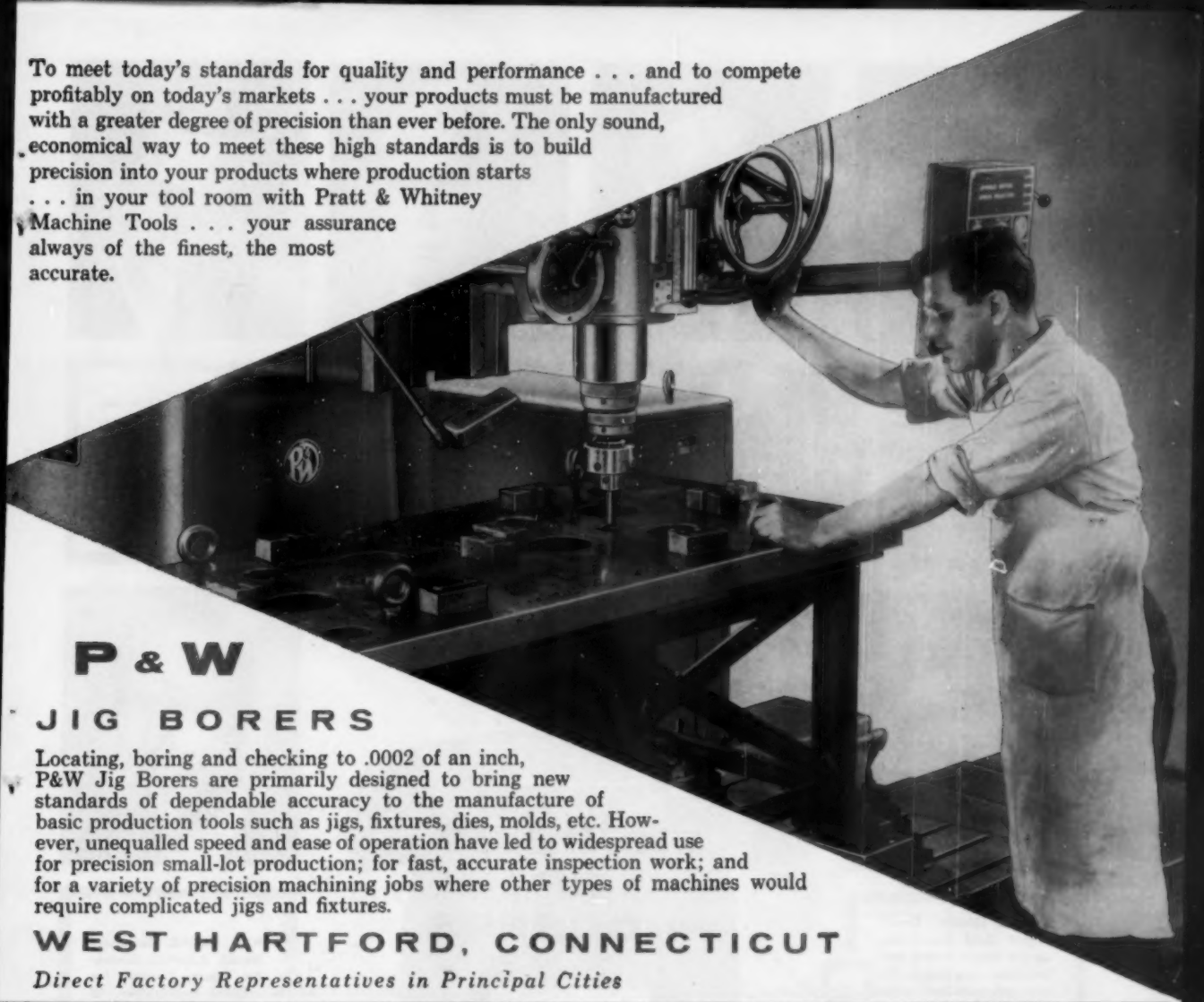


P & W

JIG BORERS

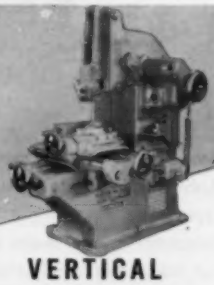
Locating, boring and checking to .0002 of an inch, P&W Jig Borers are primarily designed to bring new standards of dependable accuracy to the manufacture of basic production tools such as jigs, fixtures, dies, molds, etc. However, unequalled speed and ease of operation have led to widespread use for precision small-lot production; for fast, accurate inspection work; and for a variety of precision machining jobs where other types of machines would require complicated jigs and fixtures.

WEST HARTFORD, CONNECTICUT

Direct Factory Representatives in Principal Cities

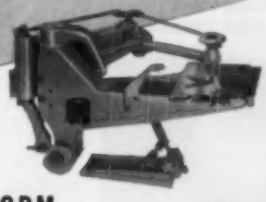
VERTICAL MILLERS AND PROFILERS

Economical production profiling of irregular shaped parts.



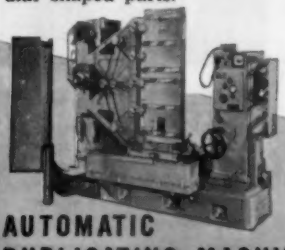
VERTICAL SHAPERS

Handiest machine in any shop for fast, accurate handling of irregular shaped work.



DIAFORM WHEEL FORMING ATTACHMENTS

Form-trues grinding wheels, accurate to "tenths" in minutes; saves time, money.

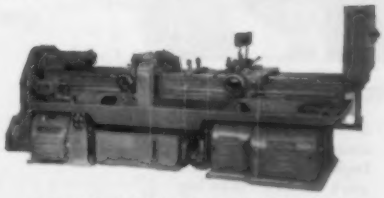


AUTOMATIC DUPLICATING MACHINES

Duplicates die and bottle mold sections . . . quickly, accurately, economically.

MODEL C THREAD MILLERS

Unusually versatile; sets new standards for accuracy, finish and economy.

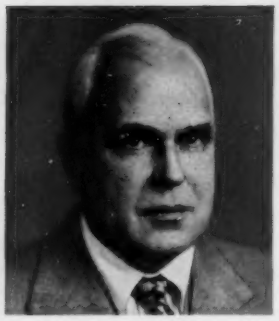


DEEP HOLE DRILLERS

Twin drilling units produce true holes up to 129" deep in a single, uninterrupted operation.

WARREN A. MARRISON. Tompion Gold Medal, Worshipful Company of Clockmakers of the City of London, for pioneer work on development of quartz crystal oscillators as precision standards of time.

W. G. PFANN. Mathewson Gold Medal, American Institute of Mining and Metallurgical Engineers, for discovery of and pioneering research in zone melting.



H. T. FRIIS. Medal of Honor, Institute of Radio Engineers and Valdemar Poulsen Gold Medal, Danish Academy of Technical Sciences; important work in application of short and ultra-short radio waves.

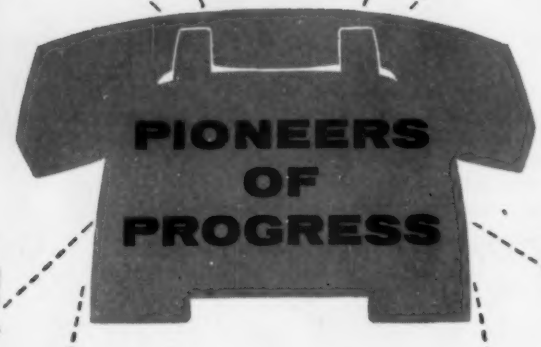
CLAUDE E. SHANNON. Stuart Ballantine Medal, Franklin Institute of the State of Pennsylvania, for contributions to a comprehensive theory of communication.

AXEL G. JENSEN. David Sarnoff Gold Medal, Society of Motion Picture and Television Engineers, for technical contributions to television; G.A. Hagemann Gold Medal for Industrial Research, Royal Technical College, Copenhagen.

H. F. DODGE. Shewhart Medal, American Society for Quality Control, for original contributions to the art of statistical quality control.

R. KOMPFNER. Duddell Medal, Physical Society of England, for his original work on the traveling wave tube.

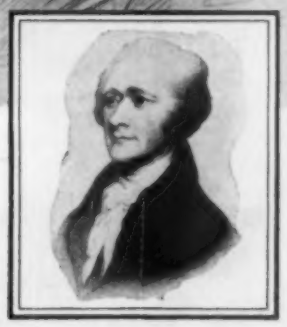
WALTER H. BRATTAIN. Co-winner with Dr. John Bardeen of John Scott Medals, City of Philadelphia, for invention of the transistor.



These are some of our recent medal winners at Bell Laboratories. The awards they have won symbolize recognition for outstanding achievement in the many sciences that bear on telephony. Bell Labs is extremely proud of them—and of the thousands of scientists and engineers who work with them to keep the American telephone system the greatest in the world.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT



Hunting~and America's First Wizard of the Purse String

For all their beauty, many portraits of Alexander Hamilton present only one side of his character. Hamilton was more than a genteel intellectual who helped build our financial foundation. This brilliant man had a fighter's heart and proved it under fire at Yorktown.

His love of action practically dictated that he should be a hunter. Records tell us: "In Hamilton's periods of relaxation he was to be seen wandering through the woods of Harlem with a single-barrelled fowling-piece, on the look for woodcock or other game." It's a long way from finance and Federalism to hunting, but Alexander Hamilton spanned the gap with ease. This sport had what he wanted.

Since pre-Revolutionary days, Americans have looked to hunting for thrilling action and healthy exercise. It's a rewarding sport, a sport that challenges wits, reflexes, stamina and skill. Equally important, it's known as a builder of self-reliance and endurance . . . in its own way helping to keep our nation strong.

Today, the great American tradition of hunting can be perpetuated only by thoughtful preservation of wildlife. Throughout the country, hunting associations are cooperating with public agencies to promote proper conservation. Do your part in preserving this heritage—join or support one of the groups now. E. I. du Pont de Nemours & Co. (Inc.), Explosives Dept., Wilmington 98, Delaware.

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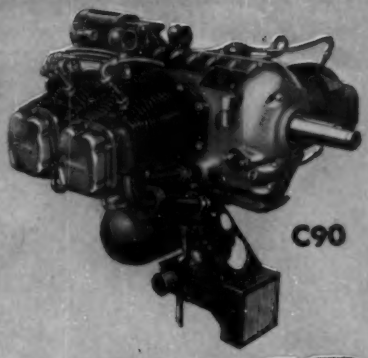
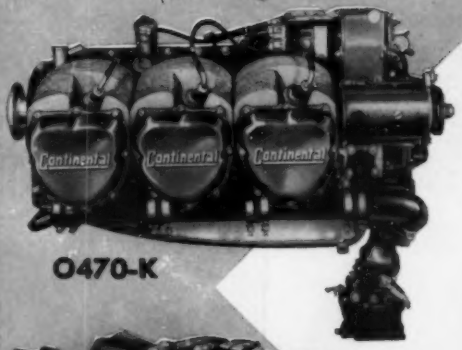
BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

CONTINENTAL MEANS DEPENDABLE POWER

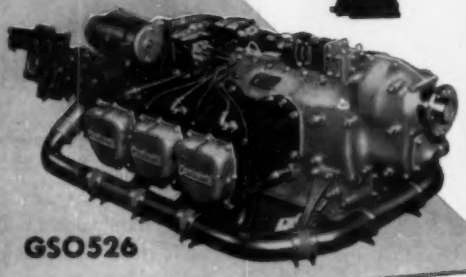
. . . PLUS THE BACKING OF ESTABLISHED AND EXPANDING SERVICE



C90



O470-K



GSO526

Continental's family of aircraft power plants—65 to 320 hp—is broader and more diversified today than ever before. Continentals give you dependability born of more than 52 years' engine-building experience, and backed by a steadily-growing network of ground facilities—factory-approved service and genuine Continental parts—all over the world, wherever people fly. Write for information.

	A65	C90	O300	*O470-K	O470-2	FSO470	GSO526
HP	65	95	145	230	265	260	320
RPM	2300	2625	2700	2600	2600	3000	3000
Cyl.	4	4	6	6	6	6	6
Wt.**	170	186.5	311	438	515	565	560
Fuel Octane	73	80	80	80	91/96	91/96	91/96

*Also available in 240-hp version as Model O470-M.
**Engine weight is complete with accessories.

CONTINENTAL MOTORS — Powerful as the Nation — AMERICA'S STANDARD

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DOW CORNING CORPORATION

Silicone Dielectrics

ELECTRICAL AND ELECTRONIC NEWS No. 7

Silastic Impregnated Sleeving Insulates Lead Wire In Strip Heater

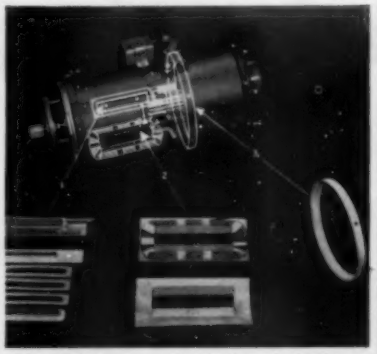
Braided glass sleeving impregnated with Silastic, Dow Corning's silicone rubber, retains excellent flexibility and insulating effectiveness at temperatures that cause rapid failure of organic electrical insulating materials. The advantages of such sleeving are demonstrated in the small strip heaters manufactured by Watlow Electric Co., of St. Louis.

Not much larger than elbow spaghetti, these efficient 175 watt heating units are used by aircraft builders and other metal working companies to heat aluminum during dimpling or countersinking to provide flush mounting of rivets. Most aluminum alloys cannot be formed cold without setting up stresses.

Slipped over the dimpling die-tips, the heaters produce temperatures of 500 F and higher. The lead wires flex continually with movements of the die. To protect the lead wire with a high dielectric strength material that retains good flexibility at high temperatures, Watlow uses Turbo 117, a Silastic impregnated sleeving fabricated by The William Brand Co. Watlow reports silicone insulated sleeving has substantially reduced lead wire failures. *No. 27*

CLASS H MOTOR STILL ON TEST AFTER 58,090 HOURS AT 240 C

At 10 A.M., June 6, 1946, a Class H insulated 10 hp motor was generator loaded to operate at its test temperature of 240 C in Dow Corning's motor test labs. Every 500 hours since it has been shut down and exposed to 100% relative humidity for 24 hours. As of 11 A. M. July 1, 1956, this motor was still on test after 58,090 hours at an average copper temperature of 240 C! That's equivalent to 353 years operation at the Class H temperature of 180 C.



Silicone-glass components: 1. interpole insulator; 2. shunt field coil insulator; 3. insulator ring.

SILICONE-GLASS LAMINATES CUT SIZE OF TURBOJET GENERATOR

By utilizing the superior thermal stability and dielectric strength of silicone-glass laminates, Red Bank Division of Bendix Aviation Corporation has designed new compactness and efficiency into a generator that meets the rugged requirements of turbojet operation.

This Type 30E10-1 Generator, a 30-volt 400 amp unit, is 6½ inches in diameter and weighs only 67 pounds. Developed to operate at speeds as high as 8000 rpm and for air-blast cooling at altitudes up to 65,000 feet, it features light weight insulating components formed of 2-ply silicone-glass cloth fabricated by Stevens Products, East Orange, N. J.

The extremely thin-walled construction of these parts provides more space for circulation of cooling air than possible with the several layers of tape conventionally used. In addition, the silicone-glass laminates are lighter in weight than the tape insulation. Quickly "snapped" into place, they effect substantial savings in assembly time and costs. *No. 28*

"Potting Gives Maximum Reliability", an article from ELECTRONIC EQUIPMENT, describes the method of encapsulating a new series of electronic devices developed by the Naval Ordnance laboratory. Using silicones helps to provide the utmost protection against mechanical and thermal shock, vibration, and humidity. *No. 29*

Documentary film "What's a Silicone?" available free of charge for showing to technical audiences. For more information circle *No. 30*

Waterproof Wire Splice With Silicone Compound

The sales success of "Super-Splice", designed by Superior Cable Corporation, Hickory, N. C., testifies to the superior dielectric properties of Dow Corning silicone compound. Over 2,000,000 of the splices have been sold in the last two years.

Originally developed for telephone cable work, the "Super-Splice" is a simple polyethylene sleeve sealed at one end and filled with grease-like Dow Corning silicone compound. It is quickly and easily slipped over twisted pigtails to form a splice that retains optimum electrical insulating properties despite prolonged exposure to moisture.

Extensive laboratory tests have proved that "Super-Splice" retains its full insulating effectiveness even after a full year under water. During these tests, splices featuring polyethylene-insulated wire protected with silicone-filled "Super-Splice" withstood 45,000 volts dc and measured 200,000 megohms insulation resistance while immersed in water.

Since the silicone compound does not harden with aging, the insulator may be removed at any time to facilitate maintenance. "Super-Splices" now available are 2⅛" long and are suitable for straight, butt or bridge splices of 19, 22 or 24 gauge wire. *No. 31*

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Midland, Michigan
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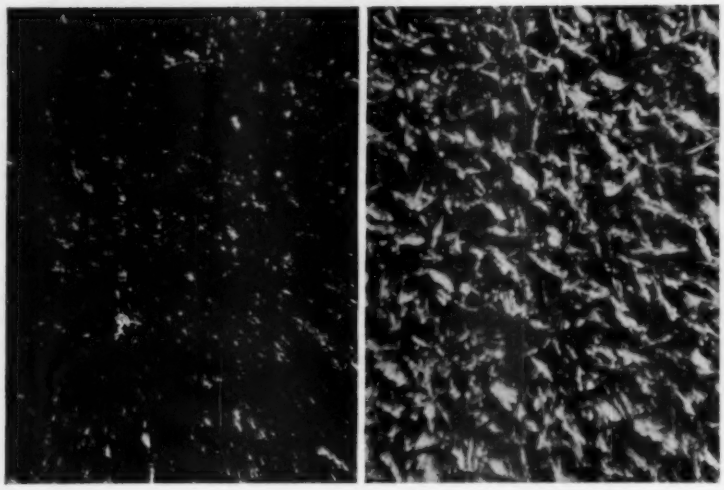
ATLANTA • BOSTON • CHICAGO • CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEW YORK • WASHINGTON, D. C. (Silver Spring, Md.)
Canada: Dow Corning Silicones Ltd., Toronto; **Great Britain:** Midland Silicones Ltd., London; **France:** St. Gobain, Paris

CrysCoat* first, then paint...

to greatly prolong finish life

Left: Cold rolled steel greatly magnified. This surface is unprotected against electro-chemically-caused corrosion, and adds nothing to the adhesion of paint.

Right: Identical panel, after Oakite zinc phosphating. Now it has *integral* protection against rust, and a better paint-gripping surface.



Metal surfaces become a better base for organic finishes when put through the Oakite CrysCoat Process. They're cleaned and phosphate-coated at the same time. The inert coating formed is integral with the surface. It not only provides plenty of "tooth" to grip paint finishes tenaciously, but also blocks rusting and prevents "creeping corrosion" under the paint film.

Famous-name products of all kinds are today being CrysCoated first for a finish that looks better, lasts longer.

There's an Oakite CrysCoat Process to suit *your* specific set-up and production needs, too. CrysCoating for zinc or iron phosphate coatings can be done by spray-washer or by tank...and with easy control, economy of solution make-up and other operating advantages. Send for Bulletin F.8979R and F.9475 which describe CrysCoat Processes ...or better still, let the CrysCoat Man give you all the details.

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A complete phosphating process by Oakite.

SPECIALIZED INDUSTRIAL CLEANING

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SCIENCE

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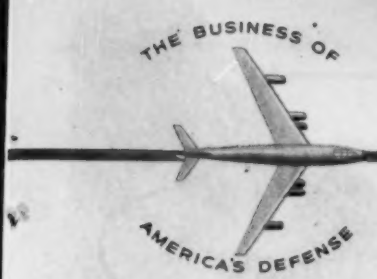

HOW FAST CAN AMERICA STRIKE BACK?

America's defense is keyed to halt aggression almost before it starts. In mere seconds, bombers of our Strategic Air Command, guided by a new bombing and navigational system, will be able to take to the air, seek out, and smash any threat of war aimed in our direction.

Heart of this new IBM-built bombing and navigational equipment is an electronic computer. With speed and accuracy never before possible, it sifts through reams of critical flight and target data and translates them into vital facts for a safe and successful mission.

These computers are IBM's answer to a defense problem outlined by the Air Force. They provide mighty proof of the force generated when America's military minds team up with American business skills.

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FACTS

about

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BALL BEARINGS

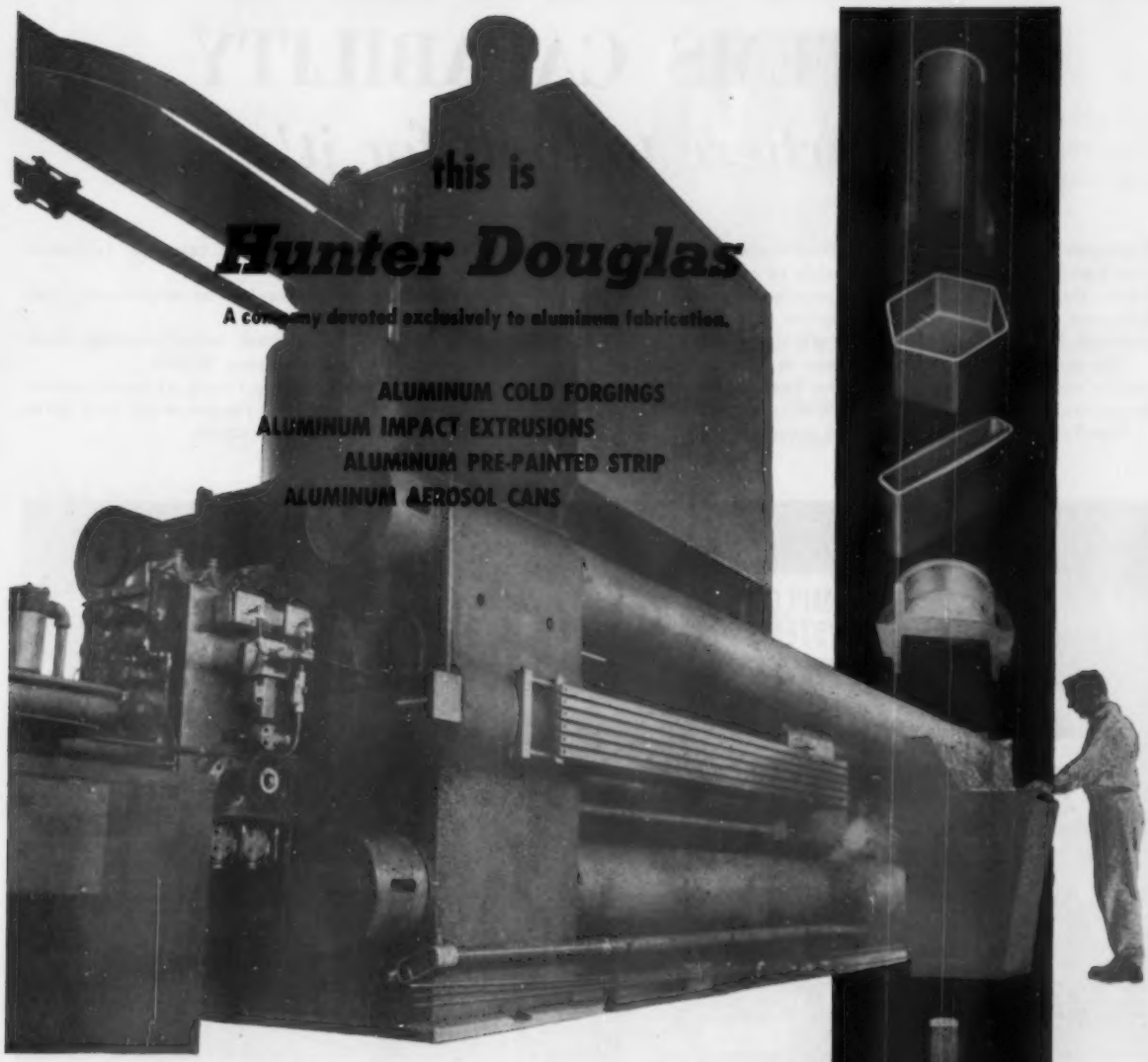
EXPERIENCE...

FOUNDATION OF OUTSTANDING QUALITY

● In manufacturing highly specialized precision products, such as New Departure ball bearings, there is no short cut to the knowledge and skill gained by long experience. The superiority of the methods, materials and the products resulting from New Departure's sixty years of manufacturing experience is recognized wherever precision ball bearings are used.

BALL BEARINGS MAKE GOOD MACHINES BETTER

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.



The name and reputation of Hunter Douglas stems from many activities related to aluminum fabrication. Cold forging of aluminum and its alloys is an important contribution. Advanced cold forging techniques, coupled with constantly growing facilities, now place Hunter Douglas among the world's leading suppliers of aluminum cold forgings and impact extrusions.

Unusual integration of plant facilities from raw material to finished product supply strong economic advantages for using this comparatively new aluminum cold forging process. Many "firsts" in solving complex tooling problems at Hunter Douglas have tremendously increased the scope of cold forging... in variety of part geometry and in component size.

Hunter Douglas engineering and fabrication resources can work to your advantage when parts are required in mass quantities. Our sales engineering department will welcome the opportunity to assist in developing your aluminum cold forging applications.

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Hunter Douglas Aluminum Corporation

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SYSTEMS CAPABILITY
—where to look for it!

For systems work, at the discussion stage particularly, you must look beyond narrow fields of capability. The norm should be a company's past and present performance in all the technical fields and branches of industrial science systems work calls upon today.

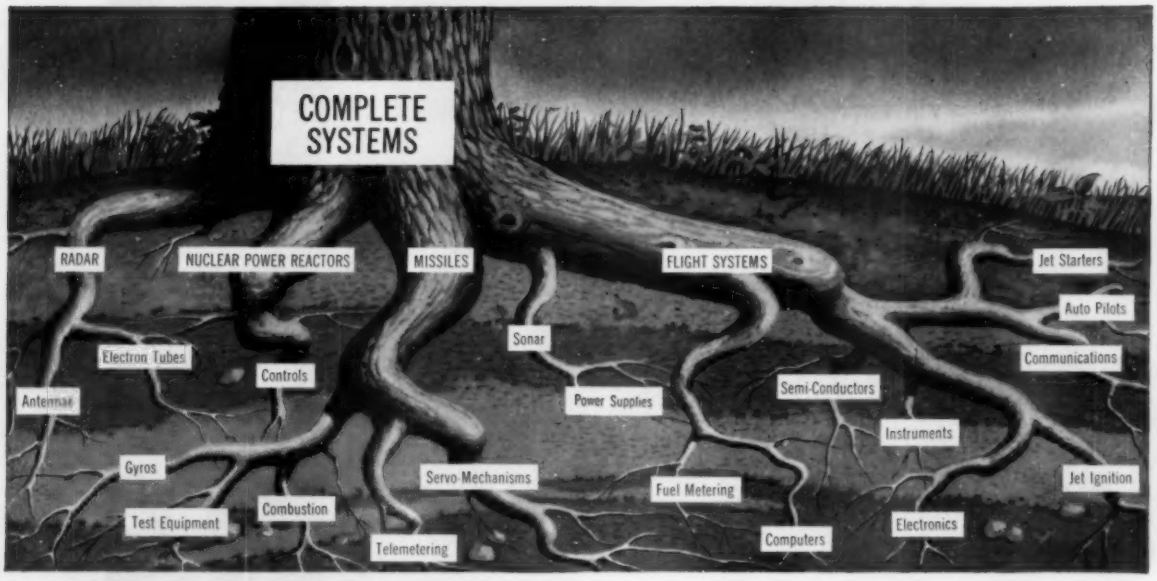
The more deeply rooted you are in all the things of which systems are comprised, the better able you are to produce completely dependable systems.

Bendix has an engineering and research staff of over 9,000 with an exceptionally broad range of technical abilities.

Over $80 million was expended on engineering and research functions in fiscal 1955.

Twenty-four widely dispersed manufacturing divisions located coast to coast employ 50,000.

The Bendix Systems Planning Group at headquarters in Detroit coordinates major systems work and gives you a single, centrally located contact.



Because Bendix is more deeply rooted in all the things of which systems are comprised, Bendix is better able to produce completely **DEPENDABLE SYSTEMS**

Bendix offers exceptional capabilities in every phase of systems work

DISCUSSION • CONCEPTUAL DESIGN • ANALYSIS • RESEARCH & DEVELOPMENT • PROTOTYPE DESIGN & MANUFACTURE • ENVIRONMENTAL & OPERATIONAL TESTS • SYSTEMS PRODUCTION • SUPPORT & FIELD SERVICE

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ALLOY STEELS

- N-A-X HIGH-TENSILE
- N-A-X ARMORPLATE
- N-A-X 9100 SERIES

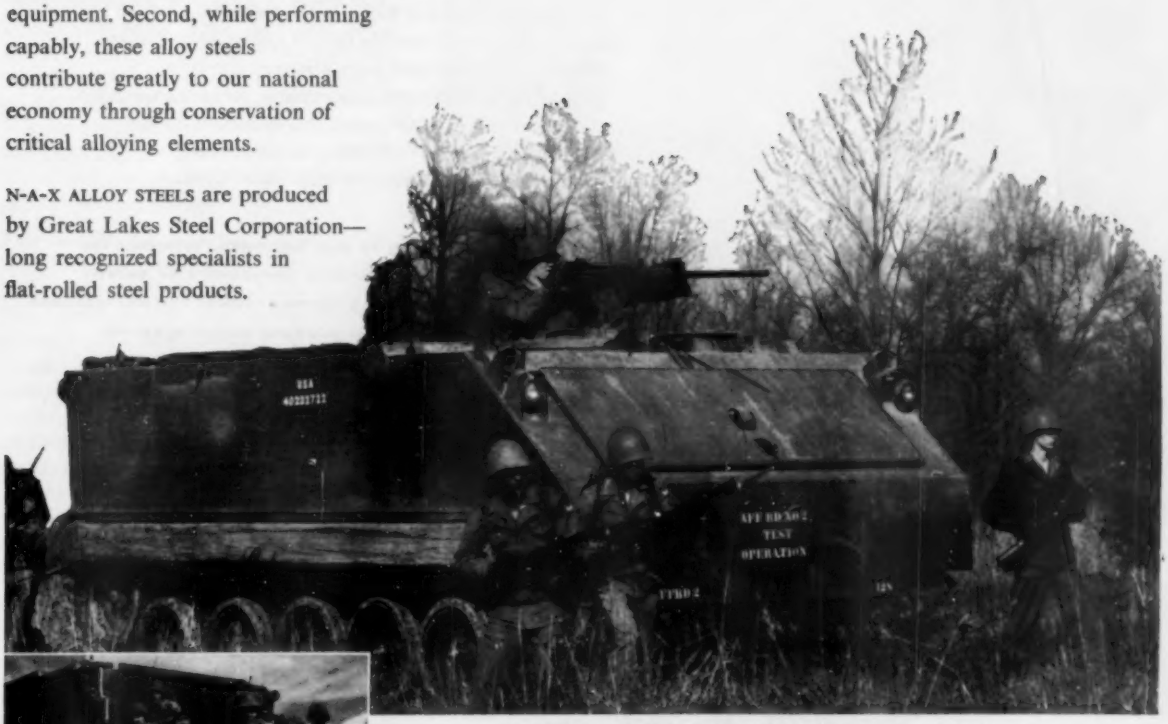
For National Defense Equipment

. . . Meet necessary rigid standards

. . . Conserve critical alloys

N-A-X ALLOY STEELS in national defense equipment serve a dual purpose. First, they readily meet the rigid standards so necessary in this type of equipment. Second, while performing capably, these alloy steels contribute greatly to our national economy through conservation of critical alloying elements.

N-A-X ALLOY STEELS are produced by Great Lakes Steel Corporation—long recognized specialists in flat-rolled steel products.



The M59 Armored Infantry Vehicle, designed and built for Army Ordnance by Food Machinery and Chemical Corporation, is an example of national defense equipment using N-A-X ALLOY STEELS.

An infantry squad leaving their M59 armored personnel carrier to assume battle positions, after being safely transported to the scene of action.

Although primarily a land vehicle, the M59 is capable of swimming rivers and lakes with ease, while fully loaded.

N-A-X Alloy Division

GREAT LAKES STEEL CORPORATION

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automatic
fire
control
by Reeves INSTRUMENT CORPORATION

USS FORRESTAL has been aptly described by Secretary of the Navy Thomas as "... the biggest ship ever built, the most complicated ship ever built, the most powerful ship ever built."

An important factor contributing toward making the Forrestal "the most powerful ship ever built" is the dependably accurate Automatic Gun Fire Control system which guides the fire of its anti-aircraft guns. Designed and built by the Reeves Instrument Corporation in conjunction with the U. S. Navy Bureau of Ordnance, this equipment, service tested on the USS FORRESTAL, has since been installed on its sister ship, the USS SARATOGA.

Systems engineering is our business. Whether for guidance, radar, fire control, computers or servo-mechanisms, Reeves has the man-power and the facilities to originate designs and produce entire systems.

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A Subsidiary of Dynamics Corporation of America
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Bundy teams up with customer in designing more efficient compressor discharge tube

Here's just a sample of the help Bundy engineers can give you with your design problems

A leading manufacturer of refrigeration compressors—and a long-time Bundy customer—had this problem: an extra-sturdy compressor discharge tube was needed for use in its new, smaller, more efficient compressor. Together, Bundy® engineers and the manufacturer worked out the ingenious solution shown at right.

Bundy customers have come to expect this kind of teamwork when they deal with Bundy. Bundy engineers take pride in solving tricky tubing problems. They'll gladly work with you at the design stages of a new product; they'll also help you iron out kinks in your present tubing designs. Either way, you benefit from their years of problem-solving experience.

You benefit, too, from the inherent qualities that make Bundyweld Steel Tubing the world's finest small-diameter tubing. Bundyweld is the only tubing double-walled from a single metal strip, copper-bonded through 360° of double-walled contact. Bundyweld is leakproof; thinner walled, yet stronger; has high thermal conductivity; has high bursting strength. Bundyweld is not only the safety standard of the refrigeration industry; *it is used in 95% of today's cars, in an average of 20 applications each.*

For help with your tubing design problem, call, write, or wire us today.

BUNDY TUBING COMPANY
DETROIT 14, MICHIGAN

Problem: Manufacturer needed extra-sturdy refrigeration-compressor discharge tube for new, smaller, more efficient compressor.

Solution: Discharge tube uses *double* tube for extra strength, superior resistance to vibration fatigue; the two separate tubes are brazed only at end fittings. Steel coil-spring sheathing muffles the noise that results from the vibration of this part. Discharge tube is designed so that O.D. of two tubes together is the same as O.D. of bifurcated Bundyweld end fittings, allowing spring to be slipped on after fittings have been brazed to double tube. Lower right: detail of formed Bundyweld end fitting.

Bundyweld starts as a single strip of copper-coated steel. Then it's
. . . continuously rolled twice around laterally into a tube of uniform thickness and passed
through a furnace. Copper coating fuses with steel. Result . . .
SIZES UP TO ⅝" O.D.
Bundyweld, double-walled and brazed through 360° of wall contact.

NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

BUNDYWELD® TUBING

DOUBLE-WALLED FROM A SINGLE STRIP

RCA's COMPACT, LIGHT-WEIGHT, HIGH-PERFORMANCE RADAR . . .

a long step toward the ultimate weapon

While the "enemy" plane is still far beyond the sight of human eyes, this new radar system detects it. Mounted in the intercepting aircraft, it provides a continuous flow of information about the "enemy position," electronically computed in terms of range and rate of closing. When visual contact has been established, the firing is controlled by the pilot, aided by electronic calculations.

In developing this compact, light-weight, high-performance radar, RCA has achieved a notable simplification of design with a minimum of components. As always, reliability and ease of maintenance have received top consideration. A feature is the bright radar display that permits viewing in broad daylight without a hood. Lock-on may be manual or automatic as the pilot desires.

OTHER MILITARY ELECTRONIC SYSTEMS DEVELOPED AND PRODUCED BY RCA INCLUDE . . .

Radar: airborne, ground and shipboard

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Fire Control Systems
Loran
Bombing & Navigation Systems
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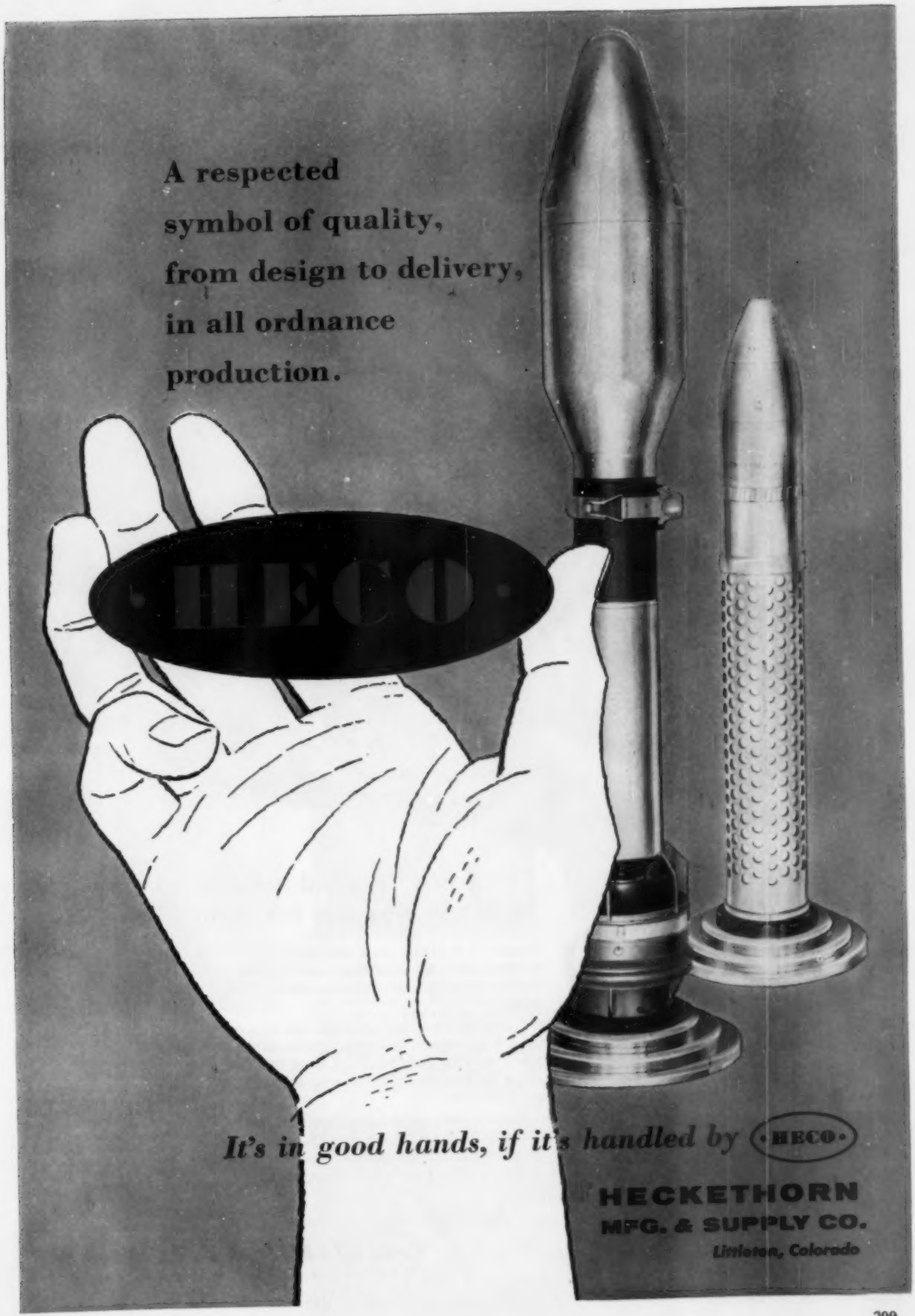
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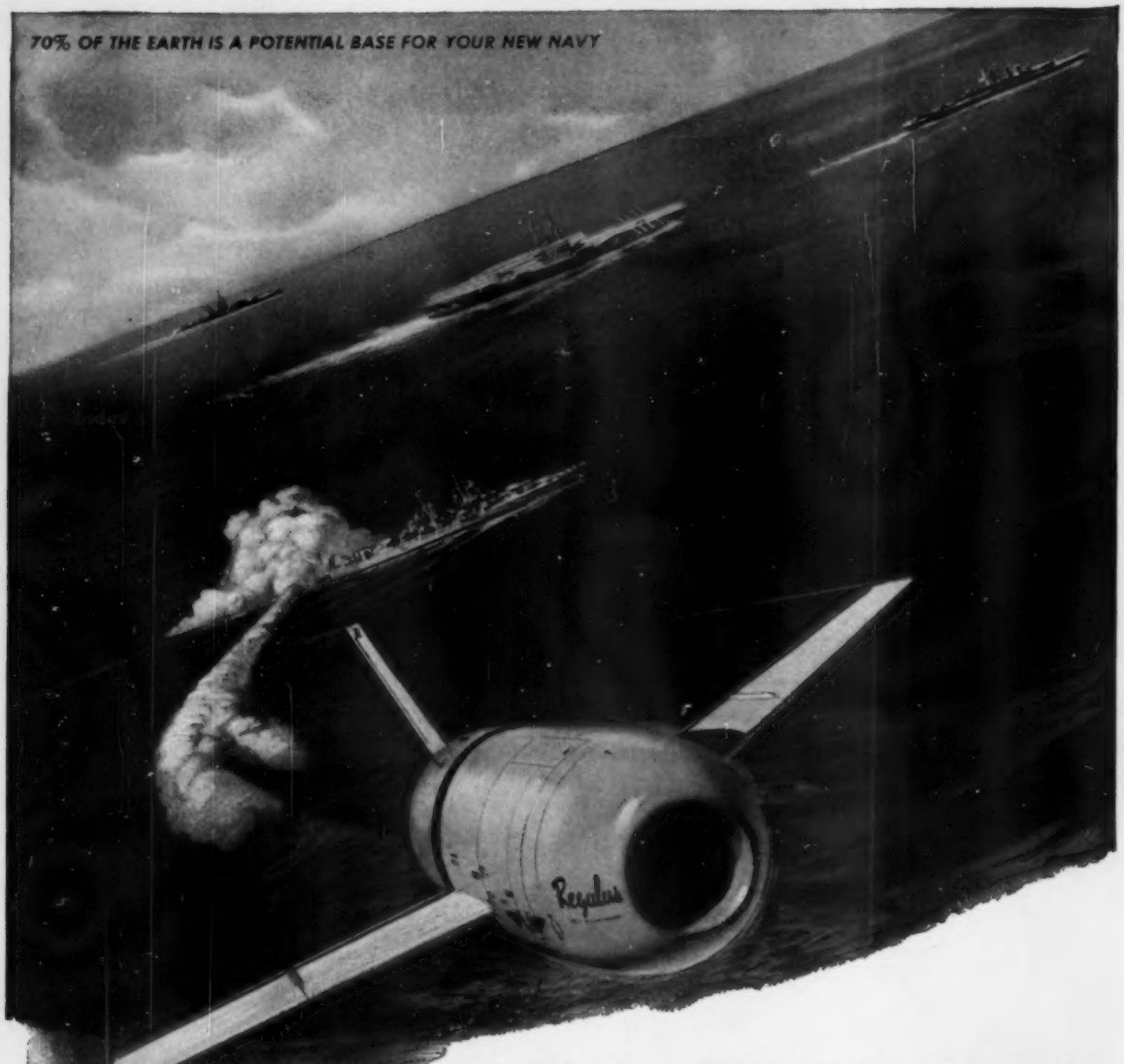

bomb that thinks

"Regulus" guided missile—a powerful defense weapon for Your New Navy

Regulus is a highly versatile, jet-propelled guided missile that can deliver a powerful warhead to an enemy target from hundreds of miles at sea.

Launched from surface ships and submarines, it is a weapon that brings greater striking power to Your New Navy—a Navy that can range the seas that comprise over 70% of the earth's surface.

Reliable and capable of performing a variety of missions, Chance Vought's *Regulus* is a prime example of the advanced weapons which now strengthen the U. S. Defense team.

YOUR NEW NAVY NEEDS MEN...

Men who can qualify for career training as seagoing specialists in any of more than 60 ratings. There are openings in electronics, radar, sonar and other important and highly skilled occupations. See your nearest Naval Recruiting Office for detailed information.

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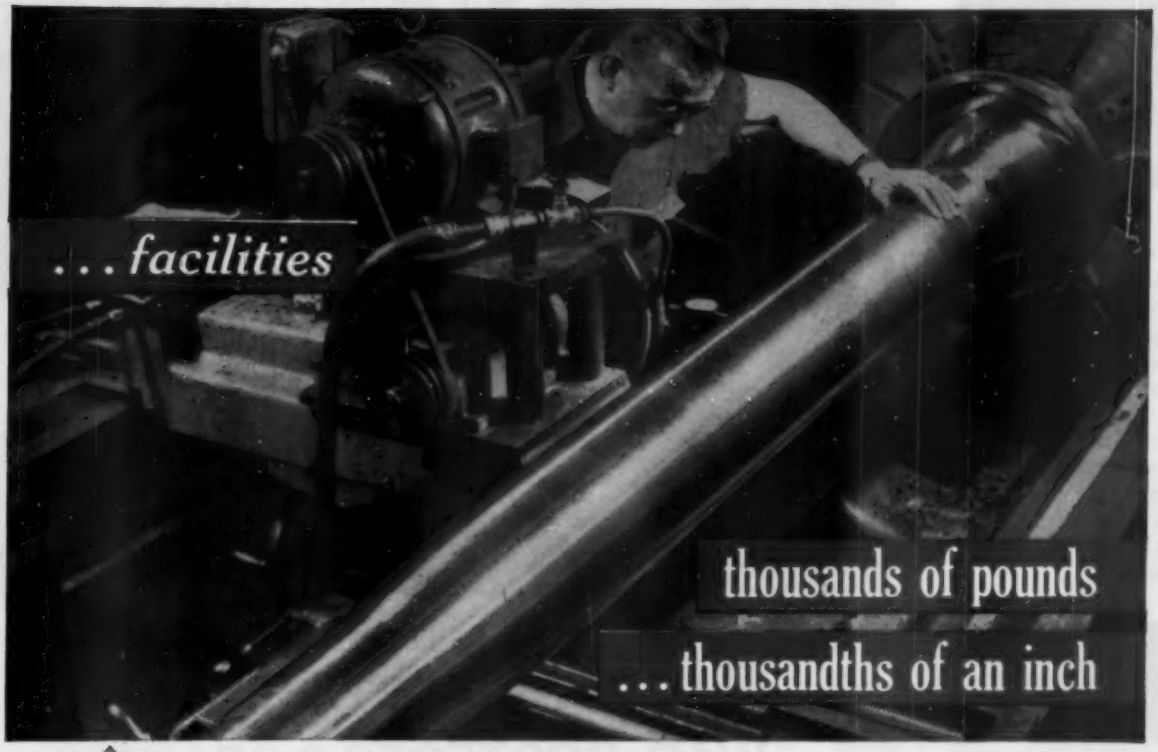

STEAM CATAPULTS FOR NAVY CARRIERS are made at Bliss' Canton plant. Shaft shown here is ground to special taper by mounting grinder on lathe post and guiding it with a specially built duplicating device.

20-mm MACHINE GUNS. Here, barrels are given a salt bath heat treatment in Bliss plant. In addition to production of 20-mm machine guns Bliss manufactures cartridge case and shell making machinery and other ordnance equipment.

NUCLEAR REACTOR CONTROL RODS produced for the AEC by Bliss. Production requirements involve unusually precise machining and welding practices.

Virtually no contract machining or fabrication job is too large for Bliss facilities. And Bliss' record of long experience and successful performance on past contracts, both civilian and military, is your assurance of precision craftsmanship. In short, before you decide who's going to build it, it's wise to get a bid from Bliss.

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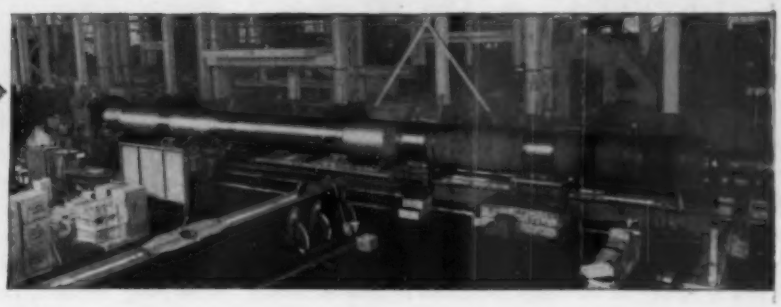
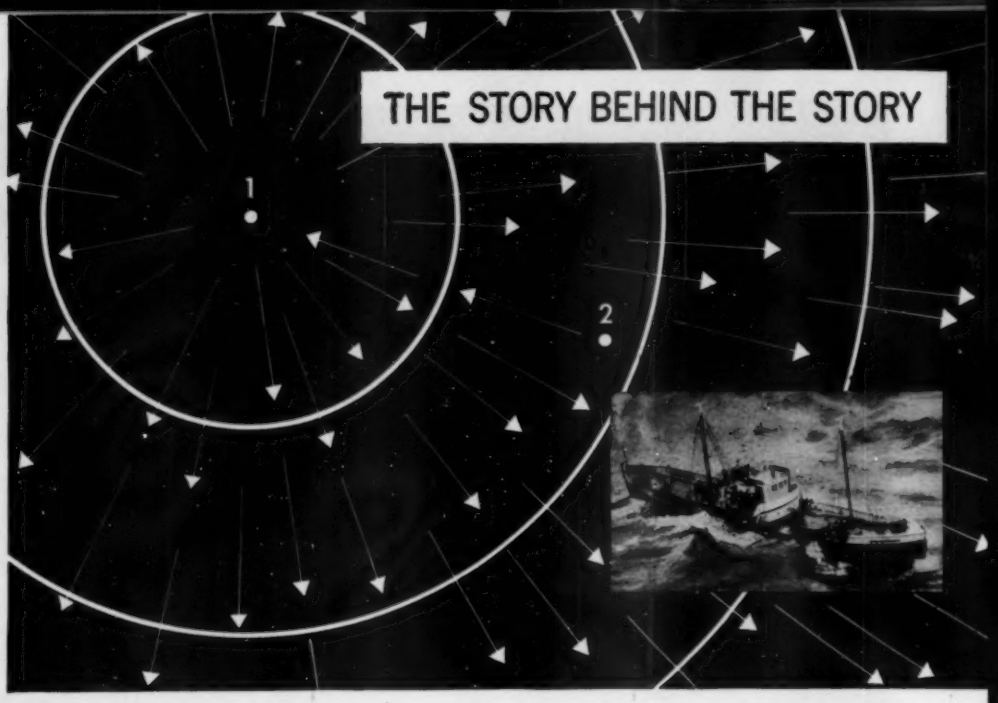
Presses, Rolling Mills, Special Machinery

Add these facilities to your own: 11 plants • 2,000,000 sq. ft. • An estimated $44,000,000 inventory of modern tools • Two Meehanite foundries, one iron and one steel foundry • Two fully equipped welding departments.

140-TON FORGINGS. The 70-foot tie rods for the great hydraulic presses built under the Air Force Heavy Press Program filled little more than half the 120-foot bed of this huge engine lathe. It is one of the more-than-100 lathes in Bliss' 675,000 sq. ft. Canton, Ohio, plant.



THE PRINCIPLE OF ALL RADAR is illustrated at right. Radio waves, indicated by arrows, bombard any objects in their path and bounce back, presenting the object on the scope and indicating its range and bearing. With his Sperry Marine Radar, for example, the master of a ship (1) sees on the scope above the image of a ship in distress 9 miles away (2) and in total darkness.



FLYING IS SAFER, and navigation is simplified for Air Force planes equipped with Sperry APN-59 Radar. For example, thunderheads and other weather disturbances are revealed in advance, so course may be altered to avoid storms.

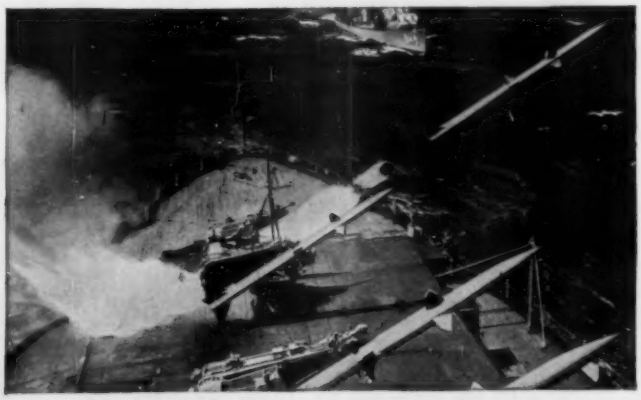
RADAR: DETERRENT TO WAR, PROTECTOR OF LIVES

Its uses Expand as its Ability to Detect the Unseen Increases

In a few short years, radar has passed from the experimental stage into a highly dependable servant of humanity. It helps to keep the peace—because its use in early warning networks reduces the possibility of successful enemy attack, while its use in new bombing and missile systems increases the probability of deadly retaliation. By pushing darkness and storms aside, it increases safety in transportation, protects property and saves lives.

To provide a thoroughly stable source of power for radar, Sperry developed the Klystron Tube. From this, Sperry has gone on to pioneer in every phase of radar development, working with every branch of the military, and with industry as well.

GUNFIRE CONTROL SYSTEMS owe much of their precision to radar. For example, an important one, this Mortar Locator developed by Sperry for the Army, uses radar to track an enemy shell, then plots its point of origin to locate an enemy battery.



MISSILES FOLLOW COURSES established by radar whether launched from air, land or shipboard, as in the case of these Navy Terriers, radar-guided by Sperry.

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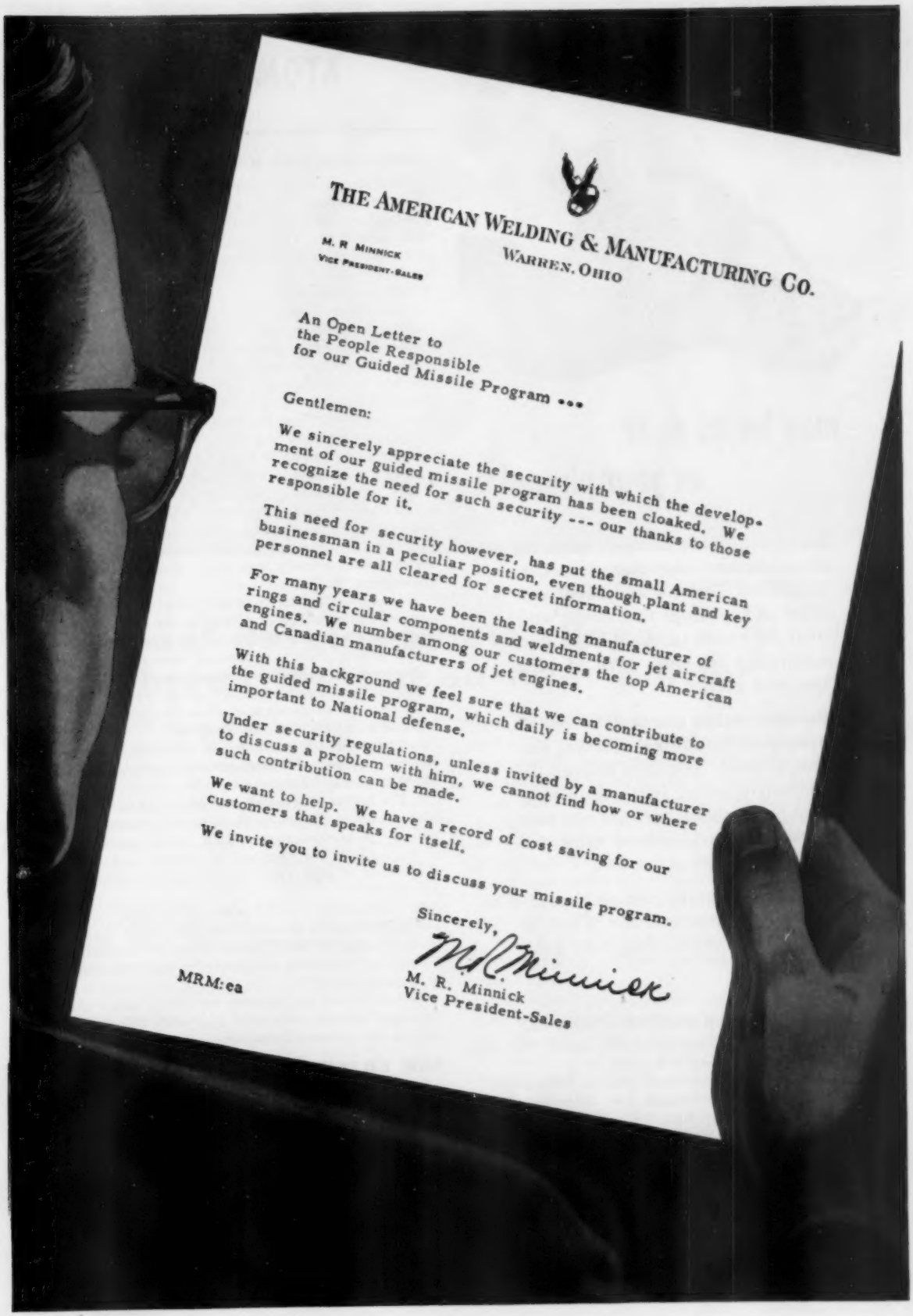
Great Neck, New York
DIVISION OF SPERRY RAND CORPORATION



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M. R MINNICK
VICE PRESIDENT-SALES

WARREN, OHIO

An Open Letter to
the People Responsible
for our Guided Missile Program •••

Gentlemen:

We sincerely appreciate the security with which the development of our guided missile program has been cloaked. We recognize the need for such security --- our thanks to those responsible for it.

This need for security however, has put the small American businessman in a peculiar position, even though plant and key personnel are all cleared for secret information.

For many years we have been the leading manufacturer of rings and circular components and weldments for jet aircraft engines. We number among our customers the top American and Canadian manufacturers of jet engines.

With this background we feel sure that we can contribute to the guided missile program, which daily is becoming more important to National defense.

Under security regulations, unless invited by a manufacturer to discuss a problem with him, we cannot find how or where such contribution can be made.

We want to help. We have a record of cost saving for our customers that speaks for itself.

We invite you to invite us to discuss your missile program.

Sincerely,

M. R. Minnick

M. R. Minnick
Vice President-Sales

MRM:ea

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Fellows has built their reputation on the solution of tough gear production problems. Fellows engineers can draw on knowledge that comes with over 50 years in the design and application of every type of high precision gear.

Fellows makes a complete line of equipment for cutting, finishing and testing gears. The Gear Shaper—in addition to cutting gears—can also be used to cut many intricate non-gear parts such as sprockets, cams and irregular shapes at low cost.

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ATOMIC ENERGY

ZIRCONIUM AND HAFNIUM PROGRAM

The Atomic Energy Commission has expanded the program for the procurement of high-purity zirconium metal and hafnium oxide to meet increasing short- and long-range reactor development requirements. The major portion of the procurement is to meet requirements of the Navy for its scheduled projects. The remainder is to meet growing needs of the Commission's reactor-development programs.

To provide an assured future supply of the materials, long-range contracts have been signed with three new commercial suppliers who were among ten firms which submitted proposals in response to an invitation by the Commission. These three contracts, covering a 5-year period, call for the annual delivery of 2,200,000 pounds of zirconium, subject to the availability of funds, at an average cost of about $14,000,000 a year.

The new long-range suppliers are: National Distillers Products Corporation which will supply one million pounds annually from new facilities to be constructed at Ashtabula, Ohio; NRC Metals Corporation, a subsidiary of the National Research Corporation of Cambridge, Mass., which will supply 700,000 pounds annually from a plant to be constructed near Pensacola, Fla.; and Carborundum Metals Company which will supply 500,000 pounds annually from a new plant to be constructed at Parkersburg, W. Va.

The contracts are for fixed unit prices which are subject to revision within established ceilings at the end of each year of production. Production is expected to begin the latter part of 1957 from new plants to be financed entirely by the suppliers.

Zirconium and hafnium requirements, which must be met during the period before production from the new plants begins, are expected to exceed present stockpile and production. These growing requirements will be met as follows:

1. Carborundum Metals Company, of Akron, N. Y., the AEC's current supplier, will increase its annual production from 200,000 pounds to 325,000 pounds.

2. The Bureau of Mines plant at Albany, Oreg., which was the pilot zirconium production plant in this country, will be reactivated to produce about 300,000 pounds annually beginning in August 1956. The plant will be operated by the Wah Chang Corporation of New York, under a contract which will expire June 30, 1958.

3. Two hundred thousand pounds of zirconium meeting AEC specifications will be imported from Japan under an arrangement made on behalf of the Commission by the Commodity Credit Corporation. Deliveries are expected to begin this year and will be completed in 1957.

Each of the new arrangements includes the procurement of all by-product hafnium oxide which is obtained from the zirconium-bearing ores processed by the suppliers.

NEW URANIUM PROGRAM

The AEC has established a new domestic uranium procurement program for the period from April 1, 1962, through December 31, 1966, and an extension of the initial production bonus for uranium ores from February 28, 1957, its present expiration date, through March 31, 1960.

The new domestic procurement program provides a guaranteed market for all uranium concentrates produced by domestic mills from domestic ores, subject to a limitation, at the Commission's option, of 500 tons of U_3O_8 per year from any one mining property or mining operation and to compliance with Commission specifications. The price established is $8 per pound of U_3O_8 contained in normal mill concentrates or precipitates.

(*Continued on p. 216*)

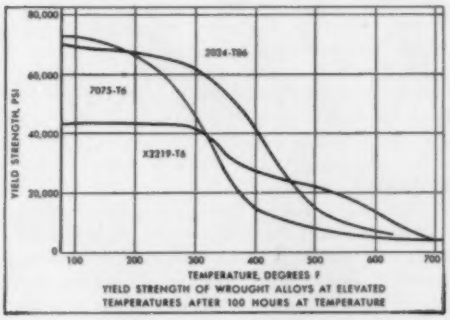
Wing skins of a new Alcoa alloy solve the aerodynamic heating problem in the F-102A.

Alcoa® develops new alloys to break the speed-heat barrier

At today's supersonic speeds, aircraft skin temperatures approach 400° F due to aerodynamic heating. Engines, de-icers, etc., add more heat so that some aircraft structural members now reach 600° —and even higher in missiles.

These high temperatures cause conventional aircraft aluminum alloys to "creep" or slowly deform under stress. To lick the problem, Alcoa has been developing new alloys which behave like many good fighting men: they really shine when the heat is on.

The chart below shows the yield strengths of three alloys at various temperatures. Alloy 7075-T6 is an old favorite for airframe structural members, and at low temperatures it's tops. Note, however, that when the temperature begins to rise its yield strength falls off quite rapidly. On the other hand, alloy 2024-T86 starts off in second place but comes into its own in the 300 to 400° range. This alloy is now used for the F-102 wing skin to withstand aerodynamic heating.



YIELD STRENGTH OF WROUGHT ALLOYS AT ELEVATED TEMPERATURES AFTER 100 HOURS AT TEMPERATURE

The real sleeper is experimental alloy X-2219, the strongest of all commercially available alloys in the 500 to 600° temperature range. With speeds constantly going up, X-2219 should have an important place in airframe structural members and engine parts.

Can Alcoa's vast experience and facilities help solve a light metals problem for you? Let us help you imagineer for the nation's defense . . . in Alcoa Aluminum. Aluminum Company of America, 950-J Alcoa Building, Pittsburgh 19, Pa.

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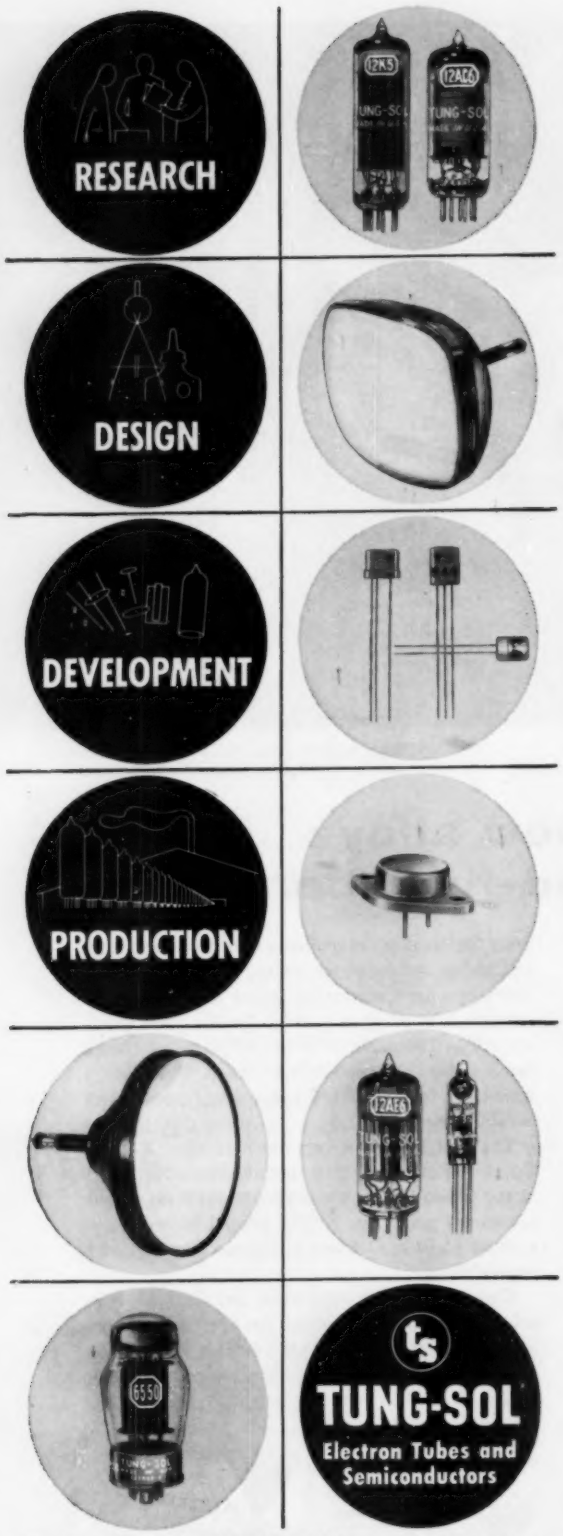

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Atomic Energy (Contd.)

This action was taken in recognition of the need for a continuing Government market in order to maintain a high rate of exploration and development.

The present uranium ore procurement program will remain in effect until March 31, 1962. The new program establishes a base price for domestic uranium concentrates, rather than ores, for the period from April 1, 1962, through December 31, 1966. The base price will be $8 per pound of U_3O_8 contained in concentrates meeting specifications. This price will be applicable to the type of concentrate (*i.e.*, high-grade chemical precipitates), which is being purchased presently under negotiated unit price contracts with milling companies.

A gradual transition from a Government-controlled uranium market to a commercial market is expected to take place as industrial demand for uranium develops.

Uranium concentrate producers desiring to sell to the Commission will be required to enter into contracts specifying the period of delivery, the quantity to be delivered, the rate of delivery, the place of delivery, the type of packaging, and other standard provisions of commercial-type contracts. The contracts may cover the period April 1, 1962, through December 31, 1966, or a shorter period.

U. S. AIDS FOREIGN ATOMIC RESEARCH

The United States Government will contribute $350,000 toward the cost of a nuclear research reactor project to be undertaken by the Netherlands Center. Financial support for the project is in accordance with the offer of President Eisenhower in June 1955 to assist other nations on nuclear research reactor programs. The funds have been made available to the Commission by the U. S. International Coöperation Administration out of Mutual Security funds and will be transferred to the Government of the Netherlands upon completion of the project.

The American Car and Foundry Industries, Inc., of New York City has been selected by the Netherlands to design, engineer, and construct the reactor itself. Design and construction of the buildings will be by a Netherland's firm. The project will be administered by the Netherlands Reactor Center, a foundation established within the Netherlands Government in July 1955.

Cost of the reactor is estimated at $2,000,000 or more and cost of the entire project may run to $3,000,000. The schedule anticipates completion of construction in 21 months following establishment of general specifications for the reactor and its associated equipment and buildings.

A similar grant has been made to the Government of Denmark. The Foster-Wheeler Corporation of New York City will design and construct the mechanical components of this reactor. Assembly and installation will be done by Danish firms in cooperation with Foster-Wheeler.

The Danes are planning a nuclear research center on a peninsula near Roskilde, some twenty miles west of Copenhagen. All laboratories and other facilities will be designed and built by Danish companies. The entire project will be operated by the Danish Atomic Energy Commission.

Brazil will also receive a contribution by the United States toward the cost of a research reactor project. The Government of Brazil will construct the reactor pursuant to the agreement for coöperation in research in effect between the two countries. It is expected that the U. S. contribution will approximate $350,000.

The Atomic Energy Commission of the National Research Council of Brazil has contracted for the construction of a 5,000-kilowatt pool-type research reactor to be located at the Atomic Energy Institute at the University of Sao Paulo. The U-235 required as fuel in the reactor will be leased to the Government of Brazil by the U. S. Atomic Energy Commission as provided for in the research agreement.

NO OBJECTION TO PUBLICATION ON GROUNDS OF MILITARY SECURITY
6 MAR 1956 15
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complete missile facilities

from conception through completion

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[redacted] missile facilities at [redacted] locations

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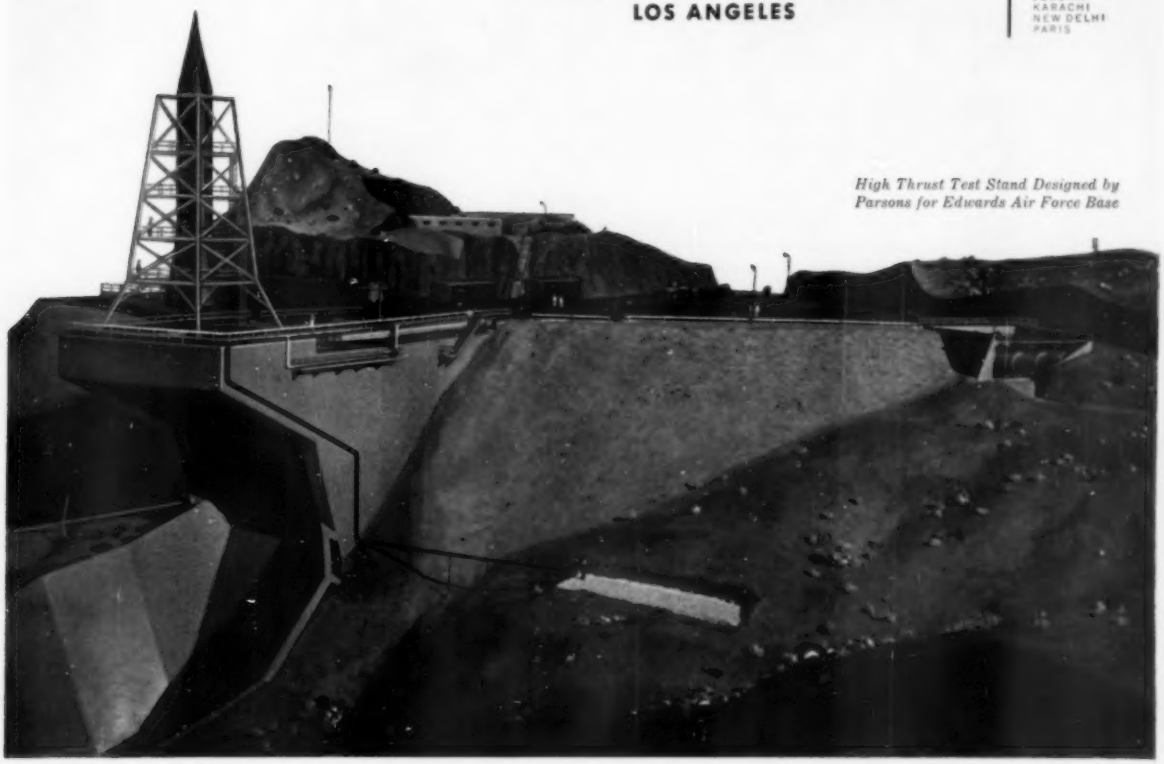

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For the United States Air Force: the B-36 intercontinental bomber, the B-58 supersonic bomber, the F-102A delta-wing supersonic interceptor, the world's first air borne atomic research reactor, "Atlas," the intercontinental ballistic missile, and the development of an atomic-powered aircraft.

For the United States Navy: the first fleet operational surface to air guided missile "Terrier," the 80-ton tradewind turboprop transport seaplane, the XFY-1 delta-wing vertical rising-and-landing "Pogo," and a study contract for naval atomic-powered aircraft.

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MAJ. GEN. JOHN B. MEDARIS

Commanding General, Army Ballistic Missile Agency

Missiles for the Army

New agency heads program for an intermediate-range ballistic missile

"I WILL find a way, or make one"—a sage remark attributed to Adm. R. E. Peary, United States Navy—expresses the philosophy governing the actions of the Army Ballistic Missile Agency.

In 1954, a committee of scientists headed by President Killian of Massachusetts Institute of Technology, made a study of medium- and long-range missiles in so far as their activities in the defense services of the United States were concerned. The 5,000-mile missile, now known as the Intercontinental Ballistic Missile (ICBM) was in various stages of development. The Killian Committee came to the conclusion that it would be easier and probably surer to develop a 1,500-nautical-mile missile than to rely entirely on the prospects of the ICBM.

On November 8, 1955, the Secretary of Defense assigned one project for a land-based 1,500-nautical-mile missile to the United States Air Force. He assigned another project jointly to the Army and the Navy—the Army to be responsible for the development of the missile system and its land-based application, and the Navy to be responsible for the development of ancillary equipment and such adaptations as were required to make the missile usable from shipboard.

The Army Ballistic Missile Agency (ABMA) was formed as an independent activity under the jurisdiction of the Chief of Ordnance of the Army. It is located at the Redstone Arsenal, Huntsville, Ala., as a "Class II" activity, which means that it is "at" the Arsenal but not a part "of" it; *i.e.*, an independent agency.

The mission of ABMA includes responsibility for the prosecution of the Redstone Missile Program and the Intermediate Range Ballistic Missile Program. The commanding general, ABMA, was delegated all of the usual responsibilities associated with such an assignment and, in consonance with the personal responsibility assigned to him, was delegated additional extraordinary powers and authorities.

Such powers and responsibilities relate to, among others, the deviation from the Army procurement procedure and related regulations; promulgation of regulations; sales or contracts for the sale or exchange of equipment, supplies, and material; and the utilization of Government-owned Army-controlled installations in support of contracts awarded in furtherance of the mission and programs of ABMA.

The IRBM was designated "Jupiter," and the Jupiter Project and the Redstone Project support each other. Many of the components to be used in the Jupiter are proven components from the Redstone, and, to save time, Redstone firings are being used to test Jupiter components as "passengers" in flight before they are used in Jupiter itself.

The Jupiter program is an extension of known principles using the same development team of Army Ordnance scientists that has worked for the past few years on the Redstone and the civilian industry teams, under contract, that are supporting the Redstone.

The methods used involve maximum urgency, as directed by the Secretary of Defense. A series of joint technical committees ensures a widespread and comprehensive system of liaison. In addition, liaison is maintained with the Air Force, with a mutual exchange of information to obviate duplication.

The ABMA organization is complete, and Jupiter is under development. The commanding general, Maj. Gen. J. B. Medaris, has a long time reputation for forceful action and effective results. He has positiveness of manner and viewpoint and the power to concentrate on means to a given end which excludes all fears of the obstacles which lie ahead. Like Admiral Peary, he will find a way—or make one.

Maj. Gen. John Bruce Medaris, United States Army, is commanding general of the Army Ballistic Missile Agency. His responsibilities include the development and establishment of the Redstone and Intermediate Range Ballistic Missiles as weapons systems for the United States Army.

Born in Milford, Ohio, May 12, 1902, he enlisted in the U. S. Marine Corps in 1918 and served in France during World War I, after which he enrolled at Ohio State University in mechanical engineering.

He was commissioned as a lieutenant of Infantry, Regular Army, in 1921 and served with the 29th and 33rd Infantry Regiments until detailed in the Ordnance Department in 1926.

In October 1927, he resigned from the Army and for ten years engaged in merchandising and management advisory activities in the business world.

In July 1939 he returned to active service and in 1942 took to the field and was successively: Battalion Commander; Ordnance Officer, II Corps, serving in the campaign in Tunisia, and the invasion of Sicily.

After V-E Day he served in turn as: Ordnance Officer, Fifth Service Command; Ordnance Officer, Army Ground Forces; and Chief, U. S. Army Mission to Argentina from 1949 to 1952.

In May 1953 he became chief of the Ammunition Branch, Industrial Division, Office of the Chief of Ordnance, which position he held until his assignment as Assistant Chief of Ordnance and chief of the Industrial Division in November 1953.

He was promoted to the rank of major general on September 15, 1955, and in November of that year was designated as commanding general of the Army Ballistic Missile Agency, Huntsville, Ala.

Rational Nuclear Armament

Our manufacture of atomic weapons should be governed by two principles: (1) Such weapons should be demonstrably useful for the purposes of war, and (2) The use of force should be subject to the dictates of conscience

Hon. Thomas E. Murray

MY purpose here will be to present some ideas that may help in forming a national policy so urgently needed in the nuclear age. This policy must be based on all the facts about nuclear weapons—our need of them, their usefulness, and the dangers connected with their misuse.

On February 23, 1956, I appeared in executive session before the Joint Committee on Atomic Energy. At this time I made recommendations pertaining to our nuclear weapons program and our nuclear power program. As the weapons program has the more important and immediate bearing on disarmament I shall limit my remarks here to weapons.

What I have to say on disarmament may be put in one straightforward proposition. In the existent state of world affairs, disarmament means rational armament, especially in the nuclear field. This is the difficult field and the dangerous field, in which rationality is of supreme importance.

DISARMAMENT doubtless means much more than rational nuclear armament. But if it does not mean at least rational nuclear armament it means nothing.

Before developing my proposals I should like to comment on one central aspect of the past history of our nuclear-weapons program. The fact is that from the outset we were primarily seeking the answer to one question: What can be done with nuclear energy in the form of bombs?

Mr. Murray is a member of the United States Atomic Energy Commission, Washington, D. C. This article was originally presented as a statement before the Subcommittee on Disarmament of the Committee on Foreign Relations, United States Senate, Washington, D. C.

The problems we faced were scientific ones. Questions concerning the development of a national policy with regard to the use of nuclear arms were not in the foreground. We were simply looking for results, always with some antecedent doubt about what the results might be.

Ever since the first nuclear explosion at Alamogordo, the specific and continuing major objective was to develop ever larger bombs. This was true of the H-bomb program, which achieved in 1952 a spectacular success.

Throughout my six years on the Commission I have strongly supported this mode of procedure. However, I long ago recognized the need of developing a national nuclear policy which could keep pace with scientific and technological progress and tried to help in developing it.

The "Mike" thermonuclear explosion on November 1, 1952, and our "Castle" tests in the spring of 1954 presented the nuclear weapons problem in an altogether different light. These tests reëmphasized in a most dramatic way the urgent need for a national nuclear policy interrelated with the types of bombs to be produced.

The major question no longer is: What can we do with nuclear energy in bombs? We know what we can do. We know that there is no upper limit to the size of bombs that can be made.

A NEW question therefore assumes the primacy: Should our future program proceed on the same basis as in the past, and with the same major objective in view—to keep on making bigger and bigger bombs? Would this, in our present circumstances, which are different from those of the past, be a rational course of action? I do not think so.

I think that policies will have to be adopted that will set our nuclear weapons program on a basis more in conformity with the realities of the present-day international life, more in conformity with certain principles of reason, and better calculated to fit into a new national policy on the use of nuclear weapons.

The new direction of our policies as I see them could be summed up in the phrase, "rational nuclear armament." This phrase means that decisions with regard to the size and type of nuclear weapons to be placed in stockpile

should be made in the light of two principles.

There is the military principle that the weapons we manufacture should be demonstrably useful for the purposes of actual war. And there is the higher principle that the use of force in warfare is subject to the dictates of the moral conscience.

The moral norm is the more important. There is something in the atmosphere of the age of violence through which we have lived, in which, indeed, we are still living, that tends to dull the moral sensibilities.

In a strange way the sheer brilliance of our technical achievements with nuclear weapons also tends to dull the moral sense. It is therefore necessary constantly to remind ourselves that a concern for justice in the use of force is an obligation upon a civilized nation.

As a "nation under God" we are obliged to act under the limitations of the moral law. The imperatives of this higher law bind us to a due measure of moderation and discrimination in the use of force. Within the Christian tradition, to which we owe our national origins, the duty of setting limitations on war and on the use of force in war has been a recognized moral obligation.

FOR instance, our moral tradition does not permit us to use nuclear weapons whose effect is mass destruction on an indiscriminate scale. As the only historical examples of the use of nuclear weapons in warfare, Hiroshima and Nagasaki are pertinent.

The weapon used on Hiroshima, for instance, was 15 kilotons or so—about 60,000 times more powerful than the largest conventional bomb of World War II. It destroyed 4 or 5 square miles of territory and killed or injured nearly 150,000 people.

At our present distance from that disastrous event, I do not think that the use of this bomb against this particular target—the city of Hiroshima and its multitudes of innocent people—could be justified on moral grounds.

The concept of a moral limitation is, I am sure, felt by the American people as a whole. However, we must beware of the false idealism lurking in the Soviet slogan, "Ban the bomb." In the discussions and negotiations looking to disarmament, it would be sheer folly to be maneuvered into making a blanket renunciation of the use of all types of nuclear weapons.

This brings me to the second principle of rational nuclear armament—the principle of military usefulness.

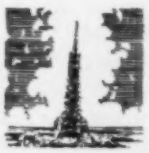
Wars in the future will be nuclear wars. This does not mean that they need be all-out nuclear wars. Such wars are no more acceptable than murder or suicide.

It would be fatal to permit ourselves to drift into the habit of thinking about nuclear war only in all-out terms. The traditional moral effort of Western civilization to impose limitations on warfare must be continued even in the nuclear age. A limited nuclear war is a possibility that our consciences can face and accept.

In the different kinds of limited war that might confront us, certain types of nuclear weapons have a genuine military usefulness. It would therefore be wrong on our part to deprive ourselves of these weapons.

However, our stockpile should include only weapons that are actually useful in war. Moreover, it should include only weapons that we can legitimately intend to use. I am altogether opposed to any school of thought that would move on toward weapons of ever-increasing magnitude, while at the same time disclaiming the intention of using them.

To say the least, this position is unrealistic. Under the stress of a threat to its survival a nation will use any weapon it has in hand, however recklessly, if there is any seeming advantage in its use against another nation.



It may be said that certain nuclear weapons, which we might not intend to use in actual warfare, are still useful as a deterrent of war, as a means of terrifying the enemy, or at least as a means of striking a "balance of terror." For my part, I think it is time we stopped for an instant to take a hard look at this concept of "deterrence" and at the complementary concept, more recently added, the "balance of terror."

I am particularly distrustful of the latter concept. There is no doubt that a balance of power is one necessary foundation, among others, of lasting world peace. Whenever this balance is upset, there is danger of aggression and of war.

This seems to be the lesson of history. However, it is by no means clear that a balance of terror furnishes an assurance that aggression even on a limited scale will not be undertaken and that it is in this sense a protection of total peace. A balance of terror is too easily upset. It is at the mercy of miscalculation. Such a balance may even put a premium on the moral cynicism that would not shrink from striking the first blow—from launching an atomic blitz.

ON the other hand, the concept of deterrence is in itself valid. Force, whether in the form of the policeman's nightstick or in the form of atomic weapons, is certainly a deterrent of injustice, aggression, lawlessness. Yet force serves as a deterrent only when the mind of the world clearly understands the exact nature of the force and that the force will actually be used.

The deterrent value of nuclear weapons is drained out of them when there is any doubt about their actually being used. In a word, the usefulness of nuclear weapons as a deterrent against war is exactly proportioned to the universally known certainty of our intention to make use of them.

Rational armament therefore should include the making and stockpiling only of such weapons as are demonstrably useful for the purpose of actual warfare. What kind of nuclear weapons, of what size, are usable and useful for the purposes of war? In other words, what manner of nuclear arms should be included in our stockpile?

The primary responsibility for answering these questions rests with the military. However, the military usefulness of a weapon cannot be evaluated apart from consideration of the moral law.

Moreover, it is my belief that decisions with regard to such questions should not be left exclusively to the

military. A due measure of participation in these decisions should be accorded the Congress and other agencies of Government.

Moral judgments with regard to the measure and kind of destruction that may legitimately be wrought are often difficult to make in the concrete. Yet, I would emphasize the fact that the demands of morality control military action in the same way that they control all manner of human action. It cannot be maintained that man's obligation to act as a man, that is, in obedience to the moral law, ceases the moment he goes to war.

Furthermore a special problem presents itself in judging the military usefulness of large thermonuclear weapons. We now know a great deal more about the effects of nuclear explosions than we did a few years ago. For instance, we now know more about the contamination of the atmosphere and soil by radioactive strontium.

Yet knowledge of important aspects of the problem is still not complete. Our knowledge about the genetic effects of radiation is even more incomplete. When the military usefulness of a weapon is being determined, all the knowledge that we do have must be brought to bear.

SERIOUS account must also be taken of the gaps in our knowledge; these gaps make it imperative to proceed with caution in evaluating the military usefulness of large nuclear weapons.

Here the chief question is this: How does the factor of contamination resultant from large thermonuclear explosions affect the military usefulness of these weapons? Surely it must limit their military usefulness. Indeed, in certain circumstances the factor of contamination might well cancel all seeming military usefulness. This is particularly true in view of the further fact that this contamination lingers for years and would affect life on earth long after hostilities had ended.

We come now to the question: What concrete conclusions result when these criteria of rational nuclear armament are applied. In my own mind I have reached the following conclusions. Taken together, they constitute the program of rational armament that I propose as part of the substance of disarmament.

My first proposal is that an upper limit should be set on the size of thermonuclear bombs to be placed in our stockpile. From the scientific and technological point of view there is, as I said, no upper limit to the size of bombs that can be produced. It is for us, as rational human beings, to set limits to their size on the basis of moral principles and military usefulness.

Concretely, I know of no reason why we should develop bombs more powerful than those we now have. I would add that, when a full military theory with regard to a moderate and discriminating use of nuclear weapons has been evolved in the light of moral principle, the conclusion might be that the bombs we presently have are already too large.

THIS proposal that a limit should be put to the size of thermonuclear bombs seems to have been supported by the President at a press conference on March 21st. He is reported as stating:

"While I have been told many times that there is no theoretical limit to the size of these instruments which can be made, there is, I think, a practical limit, as long as you are thinking of using it only against some one else, and there is size of targets.

"There is an old saying: 'You do not drive a tack with a sledge hammer.' So when you have gotten something of a, let's say, of a maximum tactical size, useful size, why I would think you would go no further."

"The deterrent value of nuclear weapons is drained out of them when there is any doubt about their actually being used. . . . The usefulness of nuclear weapons as a deterrent against war is exactly proportioned to the universally known certainty of our intention to make use of them. Rational armament therefore should include the making and stockpiling only of such weapons as are demonstrably useful for the purpose of actual warfare."

MY second proposal is that a limit should be set to the number of large thermonuclear bombs to be placed in stockpile. I have had the need of this policy in mind ever since November 1, 1952, when I witnessed the "Mike" thermonuclear detonation at Eniwetok. That event impressed me with a lasting sense of the menace to humanity inherent in an unlimited program of nuclear armament.

Shortly thereafter I made a public statement that "mankind now has within the range of his grasp the means to exterminate the human race." For three years I have consistently and repeatedly tried to convey this fact to the American public.

This same consciousness of ultimate danger appears in the testimony given by the Secretary of State, Mr. Dulles, before your Committee. He said: "The destructive power of modern weapons is such that a major war with those weapons would inevitably destroy a great part of the human race. . . ." He also spoke about "the risk of doing nothing and allowing this menace to go on in increasing proportions. . . ."

MY third proposal is that increasing concentration should be set on the stockpiling of a wide range of very small nuclear weapons.

The reasons for this proposal are both military and moral. I have said that limited nuclear war is a possibility that the moral conscience can face and accept. It is also a possibility that is inherent in the present state of international tensions.

We have, of course, been preparing against this possibility by our program for small weapons. However, this program requires greater intensification, to the end that it will put us in possession as soon as possible of larger numbers of small weapons. When I speak of small weapons I mean very small weapons. When I speak of larger numbers I mean tens of thousands of weapons in this range. These tens of thousands of weapons could form a broad and solid base upon which could be superimposed a stockpile in the image of a

pyramid of intermediate and large size weapons.

A stockpile of this composition will support a theory of moderate and discriminating use of force against all aggression—including aggression that may be minor in degree. With this diversified nuclear armament, possessed in abundance, American and allied military forces of reasonable size would be equipped to handle all the various wartime contingencies that might arise.

We shall have to face the fact that an intensified small-weapons program will be more costly in terms of fissionable material. This increased cost would result, not only from the larger total numbers but also from the inherently less efficient utilization of material in smaller weapons. For this reason, if for no other, it will not be possible, as has been suggested, to restrict the future use of all new fissionable material to peacetime uses. . . .

An atomic artillery shell fired from the 280-mm. gun illustrates a rational tactical use of nuclear energy in warfare (Army photo).

MY fourth proposal concerns the testing of atomic weapons. The testing of small weapons must, of course, go on and even be greatly accelerated to keep pace with the intensified program that is necessary in this field.

However, I propose that the tests of multimegaton thermonuclear weapons be stopped. My proposal that they should be stopped follows from the position I have already taken; namely, that the weapons we now have in hand are large enough.

I am not recommending the cessation of these large tests on the grounds that they are dangerous to health and safety. The evidence presently available does not warrant stopping tests now for this reason.

The foregoing proposals suggest in outline a program of nuclear armament that I consider rational and necessary.

It will be asked: What effect would the adoption of this plan have upon our national security? I believe the effect would be entirely beneficial. The present nuclear superiority of the United States would be materially strengthened.

In my testimony before the Joint Committee on Atomic Energy on February 23rd I emphasized the point that "superior strength means flexible strength." And flexible strength means the fuller development of the capability for limited military use of nuclear weapons—their use in limited wars and their use in combat for limited military objectives.

Tragic weakness would result if we were to build our nuclear strength with overemphasis on large nuclear weapons.

We should possess in sufficient numbers the kind of nuclear weapons that would be useful especially in so-called limited wars. Such wars are dangerous in themselves, and there is the further danger lest they develop into full-scale conflict. We must be able to take action against this kind of limited aggression in such a way as to prevent it from developing into something more formidable. . . .

THIS menace is inherent in a stockpile of nuclear weapons that are unlimited in size and number. It is also inherent in the mentality that sees no alternatives between an uneasy hostile coexistence on the one hand and, on the other hand, an all-out nuclear war. This mentality betrays a bankruptcy both of sound military theory and of moral principle.

The fact is that many alternatives are possible between these two extremes. In proportion as these alternatives are seen to be real possibilities, and in proportion as we provide for them with a balanced arsenal of nuclear weapons, the menace of the ultimate alternative—that is, all-out nuclear war—will diminish in the minds of men. . . .

IN this present moment an obligation rests on our government to make up its own mind about what disarmament should rightly mean. In other words, the U. S. must have its own program of rational armament.

I further believe that this program must be publicly defined and explained on the highest possible level. . . .

The community of nations, of whose peace we are the foremost guardian, has the right to know how we intend concretely to exercise our guardianship.

In this same connection there is another consideration. The United States has led the world in the scientific and technological development of nuclear energy as an instrument of war. We now have a further duty thrust upon us by our leadership in this field. . . .

America's call at the moment is to independent and rational action. Our response to this call of reason is a matter of duty, and to that extent an obedience to the will of God as it manifests itself in the circumstances of human life.

Education for Leadership

Through specialized courses at civilian institutions the Army Ordnance Corps is preparing a nucleus of highly trained officers who will be able to assume the responsibilities of top command in future years

Mark S. Watson

Mr. Watson, a well-known military analyst and holder of the 1945 Pulitzer Prize for international correspondence, is a member of the staff of the Baltimore Sun *and a frequent contributor to* ORDNANCE.

AN earlier article in these columns (ORDNANCE, May-June 1955) discussed at length the impressive manner in which the Ordnance Corps of the Army has been coördinating its Officer Career Program (outlined under Technical Manual 20-605, as revised) with its Civilian Employees' Career and Management Program, to the conspicuous benefit of officers and civilians and to the demonstrable benefit of Corps efficiency.

The heart of that discussion dealt with (1) the intensification of instruction of the long-term civilian employee, whereby he could constantly obtain self-improvement and an increased likelihood of finding both continuous employment and the right spot for his particular capability, and (2) the diversifying of both theoretical and on-the-job instruction of the Ordnance career officer, whereby he would acquire over-all knowledge and an administrative skill equal to the exactions of any job to which he might be assigned.

These two forms of training and management of men's working lives, it was pointed out, combine to the advantage of the Corps quite as much as that of the individual through his entire working career. That must be the justification for the program which has been patiently designed and improved and expanded.

Younger men have to be reminded that the Corps had a good educational program before 1940, only to have it overwhelmed by war's more urgent exactions through 1945, and to have it splutter uncertainly during the succeeding "economy" years until it got under way once more.

But even older men are unlikely to know how earnestly career management has been studied and developed in recent years. And if they know its servicewide aspects, as developed in the article just mentioned, they still may be uninformed upon the leadership-training aspect, which is a different matter altogether.

Chiefs of Ordnance used to evolve with relatively little artificial effort. The Army was small, and the Ordnance Corps was small. Both in the service as a whole, and in the branches as in the arms (to use our familiar old expressions), the competent officer generally stayed until he was retired for age, learning all the time. Because the total amount of work to be done was limited, it was an easy and natural thing to "farm out" the most promising technicians to industry for their own intensive training in a number of technologies.

That is how young Levin Campbell, Jr., for example, got out to San Leandro to acquire in the Holt Caterpillar shops the knowledge and skill which a few decades later were to help make General Campbell, through his combined wisdom and skill and boldness, so remarkably competent a Chief of Ordnance.

THERE were, say, 300 officers and 10,000 civilian employees in the Ordnance establishment of a generation ago. But during the Korean affair there were 7,000 officers and 160,000 civilians, and there are something over 6,300 and 120,000, today respectively—Aberdeen Proving Ground alone is almost as large as the whole Ordnance establishment used to be. A recent comparison shows that in 1956 the total number of civilian employees is exceeded by those of no corporation save General Motors and Ford.

The Field Service used to have a few storage-and-issue depots largely for storing war reserves. Issue was a small problem for there was little to distribute to the small peacetime Army of 1921-1940. Now there is a vastly expanded distribution system greater than that of Sears, Roebuck and Montgomery Ward combined.

It is hardly surprising that with such a stupendous piling up of things to be

done, and with that rapid change of items which new weapons systems call for, there must be a radical change in methods of administration and training as well as of performance.

This goes all the way through the service, at all levels. Obviously, when there are so many more men at the lower levels, the selection and training and assignment at those levels must be as swift and sure and thorough as possible to eliminate the misfits and to develop fully the extrafit.

That recognized, it can hardly be in question that the same is true to even greater degree at upper levels. Three very considerable points must be kept in mind:

1. The tasks of high-level administration are far more complex than they used to be by reason not only of their size and number but of their variety and, in some cases, the speed with which they change their exact forms.

2. The assured years of service are fewer. A young officer used to count on thirty-four to forty years of active duty; today the average officer has thirty—if he stays in the service.

3. More has to be crammed into the thirty years. There are, for an Ordnanceman, two necessary lives—one technical and the other military—and both must be lived. Thus many officers must be sent overseas and must do their tour with the combat arms and must be assigned to non-Ordnance tours on the Staff or in the Atomic Energy Commission or elsewhere. This is as it should be, for it is an admirable thing to have them on assignment to staff groups where they can represent the Ordnance viewpoint.

AT the same time, this process cuts into the available supply of first-class officers. It has been determined that if the officer's last 10 years of predictable service are to be of maximum value to him and the Corps, all his formal education (comprising about 6½ years) must be jammed into the first 20 years. With 7 or more years of other assignments allowed for, that means that the Ordnance performance in the first 20 years is down to about 6 years.

The obvious requirement, then, is to make those 6 years fruitful, and to regard the whole 20-year period primarily as preparation for the last 10-year stretch of uninterrupted performance for the Corps.

The long-range aims include one which must never be lost sight of—the rounded training and development of a future Chief of Ordnance and his chief assistants. In the present group of lieutenants is the man who will be Chief in a matter of 20-odd years. Who is he?

Nobody knows—and the wisest thing is not to guess, beyond figuring that he surely is in a relatively small group far above the average in wisdom, in leadership, in persistence, in adaptability, and not so much in individual technological skill, desirable as that is, as in the ability to recognize the skills of others and to encourage and employ them to the country's fullest advantage in war—and in peace also.

It is not too hard to identify the likely leaders, even when they are of company rank, thanks to the close attention which can be given the scrupulously maintained records in the office of Brig. Gen. W. E. House, chief of the Army Ordnance Office of Manpower. The problem is to find for that number the vacancies desired at the time when the several promising candidates are free for an educational assignment, so constant is the drain-off into other unavoidable assignments.

THE intraservice schools themselves take a good deal of time, and should: the basic course for company officers, the advanced Ordnance officers' course, the specialty courses in guided missiles, fire control, commodities, procurement and supply, the Command and General Staff College, and the Armed Forces Staff College, and ultimately the senior courses for extremely promising men in the Industrial College of the Armed Forces, the Army War College, and the National War College.

Less known to the public, and even to much of the Army, are the highly specialized schooling courses in civilian establishments. The officers who go to them are picked by the Office of Manpower on a highly selective basis, and their progress is under almost continuous scrutiny. While the prime concern of this article—the "training of a future Chief of Ordnance"—is with one of those courses (the Executive Development Course, for lieutenant colonels), it is desirable to examine the other special courses in some detail.

GRADUATE Engineering (lieutenants and captains).—This is something of a counterpart of the old-time engineering training which a much smaller Ordnance Corps of other years was able to give some of its officers.

It is given at Purdue University, and only a limited number get it, for not all good young engineers are qualified by either their undergraduate training or their engineering experience to pursue training at this level. Indeed it is difficult to find enough such candidates on the available-for-assignment list of a given day, and while there is an annual budgetary allotment for twenty, only twelve were entered last autumn.

After the Purdue course (lasting two years) they are not specifically fitted for overseas duty, for their work has been chiefly in broad theory; hence they go on tour to apply in practice what they have just learned.

It may be in automotive technology (Detroit) or in armament (Rock Island) or in ammunition (Picatinny) or in fire control and guided missiles (Redstone, Frankford, White Sands), but they no longer go as a student group, which permitted too little useful concentration. Rather they are distributed among these plants as individuals, again on a highly selective basis, and this is thought to be much more productive.

It will be recalled that in the old days Ordnance officers were assigned before there was a clear opportunity for assessing their particular capacities. Now, by study against a variety of backgrounds, it is possible to determine individual dispositions toward engineering, or management, or administration, and to emphasize guidance a little earlier and a lot more productively.

The fact that just now there is an acute need for more young engineers and scientists is not surprising, for there

is a national need for young men well grounded in physics and chemistry and advanced mathematics—and four-fifths of the present officers in Ordnance are Reservists. Actually the Corps has but seventy-three per cent of its allowance of Regular officers, apparently because out of those who would be most welcome in this work too many find irresistible attractions in the glamour of line duty with the Rangers or the Airborne or the guided-missile elements.

"There are three continuing struggles," is the wry comment of Col. Durward E. Breakefield, chief of the Military Personnel Branch—"to get them into the Army, to get them into Ordnance, and to keep them."

IN silent explanation of that third struggle General House points to the Army Register for January 1955, containing twelve pages of close-set type recording the year's resignations of officers, mostly captains and lieutenants, to go into industry. Somewhere among them, he remarks, were one or more potential Chiefs of Ordnance who never will materialize.

Business Administration (captains and majors).—This is a 2-year course at the Babson Institute near Boston, and the current first-year group is training 8 officers in the business and management aspects of Ordnance. The graduate receives a degree (bachelor or master) in business administration. A new 14-month course in these subjects is also set up at the University of Texas, where 5 officers are currently enrolled.

Controller Practices (captains and majors).—This is a 14-month course in which 5 Ordnance officers now are enrolled. It is given at Syracuse University (corresponding closely to the specialty instruction at Harvard and Pittsburgh) and is a management course given to all the Army personnel selected for it, not to Ordnance personnel only.

It is thought of as something of an alternative to the Babson course. To one or the other the Ordnance Office of Manpower undertakes to send young officers whose promise is of excellence in management rather than in engineering.

Executive Development Course.—This is the upper-level 2-year course previously mentioned, for which lieutenant colonels are eligible. Only five a year are chosen, and this indicates sufficiently the care with which General House's office makes its selection on the basis of high individual achievement to date and higher promise for the future. It goes without saying that responsiveness to earlier schooling, as well as earlier performance on important-duty assignment, helps to guide the choices.

This carefully designed senior management schooling is so different in theory from the lick-and-a-promise training courses with which we all are familiar that it calls for a detailed description. It is given at the University of Chicago School of Business as an executive-training program in which the 5 lieutenant colonels are treated precisely like their 70 civilian fellows enrolled in this unusual 2-year enterprise.

It is a fair guess that the civilians, too (a limited number of college graduates already experienced in executive responsibility), are chosen on a selective basis sufficiently considered (in their employer companies) to justify their removal from immediately productive work for so long a period in early adult life.

The aim on the part of General House's office is to provide management training and experience annually to five chosen officers who are expected to rise to command positions where they will be responsible for Ordnance procurement through obtaining a better understanding of the problems of industry and management.

The curriculum appears admirably devised to provide continuing attention both to theory and practice, to study and performance, which will provide both a knowledge of detail and, much more important at this stage of development, a high-level grasp of "the managerial uses of economics, accounting, and statistics toward a *general-management* approach, going beyond the specific departments or functions to a companywide or an industry-wide viewpoint." It seeks to provide "greater awareness of an administrator's responsibility to his company, plus a sense of responsibility in our social-economic-political system." The quotations are from a passage directed to big-business executives who are choosing *their* promising men for high-level training. It is an impressive suggestion of what the Ordnance Corps wants its own high-level executives to possess.

The method is to make the students work in industry by day, and two nights a week to study theory in the university course. The industrial assignment changes every three months, the students spending that period successively at each of six establishments: the Chicago Ordnance District, Inland Steel Company, Borg-Warner Corporation, International Harvester Corporation, Sears, Roebuck & Company, and Motorola Corporation. They get no quick tour of a plant, but a full-time study of top-management operation.

The method of providing experience-instruction is left to the company, but each management has an understanding of the serious purpose and is pledged to further it. This marks a great advance over the old method whereby a few select men were sent to academic graduate schools and also to industry; the former half gave little of practical guidance, and the latter half usually was too poorly organized to provide much more than a prolonged plant tour.

THE new method is designed at the outset, rather, as an integrated process. The course recently completed its second scholastic year, so that the Ordnance Corps' first group of five lieutenant colonels who entered in 1954 finished their course in June 1956. It will be interesting to see, in years to come, how fully they have justified the hopes of General House and Maj. Gen. E. L. Cummings, Chief of Ordnance, who have heartily supported the new training program.

It is obvious that coöperation in training is valuable just as long as both sides of the bargain benefit. The value to Ordnance need not be argued, but what do these six industries (including the Ordnance district) gain by having five Army officers on the premises (and

at high level) for three months at a time? What is the justification for industry spending, say, $50,000 a year on the enterprise? Two benefits are visible:

1. On their side the companies learn a good deal from these experienced officers in the way of acquiring knowledge of Government procurement procedures in which some of these selected lieutenant colonels of Ordnance are well versed. The companies also stand to benefit from the outsiders' critical observations on the plant's operations.

2. These same officers will one day be in the command positions foreseen for them, and industry as a whole (including these companies) will benefit immeasurably by being able at that time to confer with officers who through actual experience know how industry works.

WHY was Chicago selected? To begin with, the university had the course already designed to provide training in managerial accounting, administrative relationships, business economics for industry and the individual, statistics for management, industrial relations, financial management, money and markets, public regulation of business, business organization and policy.

Beyond that, the city of Chicago is an unexcelled center of business and industry in great variety and of great size, where there is a superb chance both of applying theory and of assembling experience for the formulation of new theory.

As to the 3-month periods with industry, it may be helpful to note that one of the five studious officers referred to reports his own first-hand study in the plant assigned to him. He feels he has learned much about its methods of decentralizing, operations, sharp internal competition, its effective use of human resources, the bases of its decisions on operating expense, its fiscal accounting and budget design. Each of these fields has its clear bearing on Ordnance problems.

Another officer's experience is interesting in one unexpected detail: he got to the products division just as that office and the Army were terminating a cartridge-case contract. It afforded him an admirable chance to see the factors involved in that often-encountered process and to examine them from the other side of the fence.

"In the old days Ordnance officers were assigned before there was a clear opportunity for assessing their particular capacities. Now, by study against a variety of backgrounds, it is possible to determine individual dispositions toward engineering, or management, or administration, and to emphasize guidance a little earlier and a lot more productively."

The fact that the University of Chicago includes the local Ordnance district in its six training points for *civilian* students is interesting. It forces to attention the question of whether the Defense Department is equally aware of the fact that the Defense Establishment's own installations have a great deal to teach, as well as to do, and specifically whether it is not desirable to press more current routine orders into the Army's six arsenals.

There, it should be remembered, our

giants in the Ordnance Corps of past and present got their very best training, which has paid off richly in every emergency, largely because the arsenals deal habitually with products which private industry does not normally make and does not know how to make. There in those arsenals we develop and maintain our skills and develop our solid traditions.

It should not need saying that they must be kept busy enough to justify the training of officers and the retention of loyal technicians about whom, when future emergencies come, new groups can be organized quickly and efficiently.

THERE is another aspect which forces itself to attention. There have been listed above the 5 outstanding graduate schools where each year a total of 35 promising Ordnance officers are entered (Purdue 12, Babson 8, Texas 5, Syracuse 5, Chicago 5). Out of 6,300, that is a smallish number, and it is inevitable that in such circumstances almost all the 35 will be Regulars—simply because this valuable education should properly be given to officers who are likeliest to stay in the service.

Existing legislation is partly responsible for the reluctant decision that the assignments should go almost wholly to Regulars (33 of the year's 35 are Regulars), even though four-fifths of the present Ordnance officers are Reservists.

For, short as is the Regular's expectancy of service (about 30 years), the Reservist's is shorter. He is required to separate from the service after 20 years unless (1) he has an outstanding record or (2) his qualifications cannot be equaled by another. It is hard to prove either claim to a tough Secretary, and there is a five per cent limit on those exceptions, too.

IF we follow the Ordnance Career Management reasoning, previously mentioned, and think of the first twenty years as preparation, it can be seen that the Reservist's future is not sparkling, as far as very high level assignment is concerned. Corrective legislation is clearly needed, and soon.

Under that which now is operative it can be seen that while Reservists in great number are being sent to the *service* schools (the effort being to integrate them with the Regulars as fully as possible to the conspicuous benefit of the Corps), they must prove exceptional quality to justify their being sent to the five Ordnance graduate schools.

Yet we have seen many Reservists on extended active duty doing superb work, and there should be a way to give them appropriate training to get still better performance out of them before their service is terminated.

"We have to look ahead ten or twenty years," remarks General House in summary. "When that time rolls around there must be available more than one senior officer qualified for the high duties of Chief of Ordnance and a good many high-level officers qualified to be commanders of field installations and chiefs of important staff divisions. What we do now in the way of selective education and training will determine whether we have those people when they are needed."

New American Aircraft

The Air Force's new Martin B-57E twin-jet bomber, above, is especially equipped to trail an aërial target at the end of a long cable and can be converted to a tactical bomber. The Navy's Vought F8U-1 supersonic day fighter, below, has a 2-position-incidence hinged wing which raises in front, making possible level-attitude take-offs and lower-speed landings.

Competitive Coexistence

The development of a peaceful social order involves the establishment of a delicate dynamic balance between certain forces based on freedom of the individual citizen under the just and equal law of nature

Eugene E. Wilson

SINCE competition is an elemental force in nature, it follows that competitive coexistence is the working process of a social order. Competitive coexistence has been the rule since the dawn of civilization, and it promises to continue to function until the coming of the millennium. Such being the case, the subject deserves greater consideration than it currently receives from industrialists.

A review of the outline of human history reveals the fact that, in the past, competitive coexistence has been predominantly warlike or peaceful, military or economic, destructive or constructive, depending upon how men were inclined to apply the forces of muscle or mind available to them.

The creation of a civilization is therefore not an accidental process but a mental one—a result of rational analysis in which the prior art affords a reliable guide.

HOWEVER, with the recent advent of revolutionary technological developments and the release of new forces into the world, men have become inclined to assume that the lessons of history no longer apply. They therefore tend to cast about for new approaches to what are fundamentally old problems, and in so doing they abandon the very mental processes which discovered to them their new sources of energy.

In approaching the problem of nuclear air power in competitive coexistence it is essential to reason from established principles to logical conclusions, under the general guidance of human history. The high point in peaceful competitive coexistence occurred during the interval of 1815-1914. The latter portion of that interval lies within the memories of a generation of men still living. It is therefore not only history but personal experience—and hence far more convincing than mere opinion.

Mr. Wilson is former president of the United Aircraft Corporation, East Hartford, Conn., and a pioneer leader in the aircraft industry of the United States. He is a graduate of the United States Naval Academy, class of 1908, and author of the recent book, "Wings of the Dawn."

For out of our own knowledge we are assured that this was a climacteric interval in Western Christian civilization—a predominately mercantile era, an interlude of limited wars regulated by an accepted body of international law which restrained the uses of military force under the general principles laid down in the Ten Commandments.

These Commandments set forth the "thou shalt-nots"—the restraints which the minds of men must impose upon their physical forces if they are to continue to coexist in security and freedom.

The First Commandment, "Thou shalt have none other Gods before Me," has been called the first declaration of independence—a statement that no man need bow down to any tyrant but is free to choose his own course. In other words, the ideological basis of a social order based on natural law is individual freedom under the just and equal law of nature.

Freedom is therefore not just a pleasant physical condition but one of the vital, dynamic, constructive spiritual forces of the universe. The founders of Western Christian civilization selected this powerful force as the ideological basis of their social order.

The remaining forces to be brought under this ideological direction may be classified as military, economic, political, and technological. History teaches that the problem of creating a social order involves the establishment of a delicate dynamic balance between these forces, such as is maintained everywhere in nature to perform its miracles of evolution and creation. That an understanding of natural law underlies our American culture is evidenced by the reference in our Declaration of Independence to the "laws of nature and nature's God."

A survey of history from the standpoint of civilizations discloses the fact that whenever men have been free to apply themselves to the study of the physical forces and those of the human

spirit their culture has remained creative. When, however, they have tended to become preoccupied with one to the exclusion of the other, their culture has entered into a state of decline.

This was evident in the record of Grecian and Roman civilization. Western Christian civilization began its creative stage after geographic discoveries had placed Western Europe at the crossroads of maritime commerce and thus made it the focal point of a new culture.

Some students of history argue that the current preoccupation of the West with material forces, to the exclusion of the spiritual, forecasts the doom of Western Christian civilization. While this conclusion is effective propaganda, it is defeatist in character and disregards the workings of natural processes.

Everywhere in nature we observe the forces of action and reaction, challenge and response, withdrawal and return which disclose the cyclic character of natural phenomena, and they argue persuasively that we shall react to the current challenge of the barbarian and go on to evolve a new social order based on a higher level of greater freedom and increased justice.

THIS conclusion is supported by the facts in the case. The discoveries incident to scientific research and technological development made possible by freedom have now opened new horizons comparable to those which attended geographic discoveries at the beginning of the Elizabethan Era. In the field of medical science these discoveries have been so well applied that men are today able to expand their numbers almost without limit.

At the same time they have created a new vehicle, the airplane, which has opened a wholly new medium of communication, the air, capable of providing access to the natural resources which are essential to enlarged populations. Similarly, they have released new sources of energy through fission and fusion which can be used to conserve those resources and better adapt them to human use.

Simultaneously, Christian teachers have carried the creative idea of individual freedom to undeveloped lands where it has started a prairie fire that no longer can be extinguished. Starving hordes, having learned the facts of the better life, are determined to share it, if not by one process then by another. Unaware of the spiritual origins of individual freedom, and inexperienced in its methods, they are susceptible of subversion by predatory conquerors who would exploit these natural desires in order to enhance their personal power.

TO date the West has fallen into the error of using the airplane as a carrier of lethal weapons to be used against urban populations in defiance of international law. And the weapon carried is an explosive force derived from the products of fission and fusion.

In so doing the West has run counter to the principles which made its social order creative—a course which, if continued, must lead the world into disaster. Its task then is to reverse the trend and restore the principles which made it strong.

These, as we have seen, were derived from the principle of individual freedom under just and equal law. To revitalize our own culture we must make it predominantly economic rather than military, while preserving the military force necessary to make resort to war less profitable. To this end new discoveries as well as old must be directed into economic fields.

The airplane, for example, must become the new argosy of peaceful trade and commerce in a new mercantile era, a new vehicle of transportation providing freer access to the natural resources which are vital to the survival of new populations. Similarly, nuclear energy must become a new source of power to conserve natural resources, create new products, and adapt them to human needs.

"To date the West has fallen into the error of using the airplane as a carrier of lethal weapons to be used against urban populations in defiance of international law. And the weapon carried is an explosive force derived from the products of fission and fusion. In so doing the West has run counter to the principles which made its social order creative—a course which, if continued, must lead the world into disaster. Its task then is to reverse the trend and restore the principles which made it strong."

Since transportation must continue as the blood stream of the new era, the application of nuclear energy to the propulsion of aircraft offers exciting opportunities for the future. Meanwhile nuclear production of power for localities not favored with natural fuels offers another key to a new culture.

For just as the engineers of the past harnessed combustion to machines for manufacturing and transporting goods and services to supply human wants, so must the technician of the future adapt nuclear fission and fusion to the same end.

WHEN men demonstrated their ability to convert matter into energy and energy into matter, they posed for themselves the greatest problem in human history—the task of creating a social order capable of exploiting that boon for the good of mankind. Here again we may take a leaf from the notebook of the past.

Military forces must be redeployed to keep open the traffic lanes—aërial, surface, and subsurface—to all proceeding upon lawful occasions. In other words, the armed forces must be diverted from their predominantly destructive rôles to those of protection. For in order that scientific research and technological development may perform their natural functions in a new social order, international freedom must be assured under international law.

This operation requires a return to the political precepts which prevailed when sovereign nations coöperated in the formulation of a body of international law of their own making which limited the uses of military force to those which human experience had demonstrated to be humanitarian, and hence strategically and morally sound.

The political precepts of that era find their clearest expression in the immortal public documents which constitute the American bible. In other words, the American, or Far Western culture, documents the elements of an advanced

social order based on greater freedom and higher justice, which must be translated into policies and actions which will lead to its general acceptance in Europe, Asia, and Africa.

FOR here is a coöperative-competitive social order in which men compete with one another in their own interest yet coöperate with each other in their enlightened self-interest through this social order. This process runs directly counter to the current trend toward collective slavery and moves steadily in the direction of individual freedom under just and equal law, national as well as international. In this process, wherein the rôle of the military is protective, expenditures for armed force are not necessarily an out-of-pocket expense. On the contrary, they are potentially capital investments in peaceful competitive coexistence because new military discoveries can be applied to the economic processes.

In the political field, the maintenance of law and order is an essential element. In other words, the processes of integration of spiritual and physical forces which gave the world a century of peace and prosperity never theretofore experienced and not since even approached, are still applicable to the creation of an advanced social order.

Obviously in this coöperative-competitive effort, private industry must play a leading rôle. The industrialist who is experienced in the creative processes of human freedom, who has faith in their efficacy, and is determined to make them work, must help to become the architect of the new order of peaceful competitive coexistence. To do so, however, he must lift his sights above the limited horizons of his own specialty and apply himself to the public weal—this in his own enlightened self-interest.

HERE is a task which might well become a part of the responsibility of those associations which presently link government and private industry in the field of public security. This liaison, which made possible those miracles of production in the design, development, and manufacture of wartime products, might well extend its energies to the formulation of a constructive policy of peaceful competitive coexistence.

High point of destruction from the air was reached in World War II by saturation bombing. Devastation above was wreaked at Duren, Germany (Air Force photo).

This task would lead these associations into the realms of social philosophy presently dominated by writers and theorists devoid of practical management experience of any kind, a place where industry could employ the talents of its most able and experienced leaders in a vital public service.

History records the fact that the interlude of peaceful, competitive coexistence which the world enjoyed from 1815-1914 was the product of such minds. In England, according to Trevelyan, "the state became subjected to the ideas of commercial and naval men who combined with the best county families in the seaboard shires to exercise a dominant influence upon public policy. Partly for that reason," he added, "the Elizabethan aroused practical idealism of the English genius to its greatest heights."

"Practical idealism" is an apt expression for the spirit which underlies the American character. The practical idealism of the American genius is the chief requirement of this critical moment in history. To the obvious question, "What good is practical idealism in the face of stupid barbarism?" the obvious answer lies in the strategic axiom that no military force can resist the power of an idea whose time has arrived.

Certainly that time is now. The ideal is clearly expressed in the principle of individual freedom under natural law. The task of reviving that spirit to give new direction to all our social forces presents a great challenge and offers a priceless opportunity to American leadership—military, economic, political, technological, and ideological.

EDITOR'S NOTE.—Writing in the January-February 1956 issue of ORDNANCE on the "Strategy of Disarmament," Mr. Wilson said: ". . . History is not just an epitaph on the tombstone of a dead civilization, but, like the financial statement of a modern corporation, it points the way to higher levels. History, like the Ten Commandments, sets forth the fundamental law without which men cannot live together in any society."

New Weapons for Old?

We may be placing too much reliance on complicated "superweapons" that have never been tested in combat instead of developing further the conventional arms whose power and producibility have been proved

Garrett Underhill

CIVIL and military thinking about defense has come to be dominated by what are commonly regarded as "new superweapons"—in particular, guided missiles and nuclear bombs. Held to be outmoded are the so-called "conventional weapons" such as guns, high-explosive projectiles and bombs, and man-operated means of air, sea, and ground locomotion.

So sweeping and unquestioned is the acceptance of the "new" and the abandonment of the "tried and true" that the situation calls for a reanalysis of the arms situation—one that deals not only with what can be established as hard fact but also with the possibility that unrecognized factors may be influencing defense thinking and attitudes.

Strange as it may seem, a case for conventional weapons may prove in the long run to be important for the "new" weapons. When modern "weaponeering" as a whole is put into proper perspective, we may be able to avert the possibility of future disillusionment with the "new superweapons" should they fail to live up to expectations. Unless foreseen and guarded against, such a disillusionment might have results as serious as may be the present neglect of conventional weapons.

First of all, it is vital to appreciate that the "new" weapons really aren't new any longer. It's startling to note how many years have passed since the inception, the first tests, and the first use of the "new" weapons projects.

Mr. Underhill is a well-known authority on military weapons. He has seen service with the Army Intelligence Corps in both the Second World War and the Korean emergency.

Seventeen years have elapsed since the late Prof. Albert Einstein proposed making the atom bomb; sixteen years since the Manhattan Project was started to make it; eleven years since the first bombs were dropped on Japan.

As for missiles, America's Dr. R. H. Goddard demonstrated modern-type solid-propellant rockets at Aberdeen Proving Ground in November 1918. He started work on liquid propellants in 1920 (a full generation ago), and the first liquid-fueled rocket nearly twenty years ago. Work on the famous German V-2 project began at Kummersdorf twenty-four years ago—the first V-2 being fired in 1942 and used against England twelve years ago.

It's over thirteen years since the bombers of the Luftwaffe's Kampfgeschwader 100 used air-to-surface guided missiles against Malta and since the Germans first test-fired the big antiaircraft guided missile rockets Wasserfall and Rheintochter and the smaller air-to-air X-4.

Although modern "missilery" has been under way for so long, guided missiles were very little used in World War II and were virtually unused in Korea. Nuclear weapons have been used just twice in one war. These points lead to a second important fact about the "new" relative to the "old": *the "new" are untried.*

Indeed it is almost historically unprecedented for a nation to take the course that America has recently and rely for defense so largely on weapons with which there has been either little or no war experience and comparatively little test and user experience.

ACCORDING to published reports up to last June, America had set off sixty-seven nuclear devices and Russia thirty. This is an insignificant quantity when compared with the number of bombs and rounds of ammunition normally needed to perfect arms and to develop user tactics and techniques (to say nothing of training). And it looks as if the risk of build-up of radioactive levels might limit atomic tests if not halt them entirely.

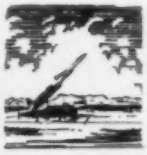
Although much has been made of the potentials of tactical atomic bombs, none has ever been used. Because of the need for radiological and other safety precautions, atomic tests with troops haven't afforded opportunities for realistic maneuvers. In the 1955 "Big Apple" blast, for instance, armored task force Razor had to be parked with vision slits sealed up when in theory it should have been charging ahead.

Since the V-2 was set on course seconds after launching, and hence wasn't a fully guided missile, it's a fact that long-range ballistic rockets have never been used in war. As is the case with all guided missiles, the cost of such rockets is a very great inhibiting factor in the development of really significant test experience in peace.

ANTIAIRCRAFT and air-to-air guided missiles also have lacked realistic tests—not just because of their own high cost but also because of the almost fabulous cost of the modern aircraft that are the missiles' proper targets. The Army's Nike, for example, arms batteries defending America's industrial and urban centers from Soviet jet bombers. However neither the Nike, nor any other antiaircraft missile for that matter, has ever aimed at a modern-type big jet bomber and brought it down.

Yet every lesson of history emphasizes that the "battle is the pay-off." Man seems unable fully to foresee what the proper rôle for a given weapon may be, so that combat often causes major changes in the concept and technique of use and in the weapon itself.

World War II soon proved that the B-17 Flying Fortress could not gain safety from fighter plane attack through speed and high flying, and from a bomber with light defensive armament it was converted into a "flying pillbox" at considerable sacrifice of performance and bomb load. But while in this gunbristling form it was able to cope with German fighters, the latter soon found a "company-front" attack technique easily able to massacre the bombers. And the Messerschmitt Stormbird jet showed it could do the same, although Hitler had thought of it as a bomber. However, the Germans made these discoveries too late.



THERE is a third basic fact about the "new superweapons" that is as important as it is difficult to interpret: *introduction of the new weapons hasn't had the immediate and sweeping direct influence on warfare that various conventional weapons have had.*

The Korean war went on for three years, as if neither nuclear weapons nor missiles existed. The same applies to other wars following V-J Day: those in Greece, Palestine, Kashmir, Malaya, Indochina, on the Chinese mainland (lost to the Reds in 1949-1950), the Chinese offshore islands, and now North Africa.

In contrast the tank was conceived in 1915, scored heavily in its 1916 debut, and has been held a major reason for the German surrender in 1918. The recoiling cannon was adopted by the German Army in 1896. In a matter of months after its appearance in the Russo-Japanese War seven years later, this "quick-firer" had changed the nature of land war.

Another obvious basic fact about the new compared with the old is that the very qualities which make the new superweapons "super" indicate that "superproblems" are inherent in their development, production, and use.

Life's rule is that you pay for what you get, so the remarkable things asked of guided missiles (in particular) mean remarkable complexity. Complexity in turn means that development time, cost, and reliability are all proportionate to the degree of complexity.

Compare a guided missile and a cannon shell. Consider the relative number of components, of functioning parts, and their nature and delicacy. The missile has many more and more delicate parts, hence there are more to make and to go wrong.

ALSO consider the years of vast industry-user experience behind the cannon shell and the fact that difficulties are still encountered in the manufacture, handling, storage, transport, and use of this comparatively elementary military item. Then think of the mis-

U. S. airlines have ordered jets like the Boeing 707 but proven piston-engined ships will still dominate the near future.

sile with its electronics and our amount of experience with it relative to cannon shell.

During the last ten years America has been slaving to solve missile problems turned up by the Germans years ago.

And as a Navy night-fighting expert has put it: "With all there is to go wrong in missiles, lots of fools will have to fool around with them a very long time before they are foolproof."

The solution of the "new" versus "conventional" weapons problem may require answers to questions like these:

What influence on weaponeering is exerted by the conditioning of the American mind over the past thirty years by highly developed advertising and sales techniques making a cult of "newness" and creating a sensitivity to the "magic of words that sell"?

In sales, "new" is the key word replacing "tried and true," and perhaps "nuclear," "guided missile," and "electronic" are merely military counterparts of "power steering," "split-level living," and "wall-to-wall carpeting."

Has the American mind, like the French, a penchant for theory in terms of oversimplified and doctrinaire "absolutist" rationalism?

Such thinking leads to belief in a "single weapon" and "one best way of war" rather than an approach realizing that anything can happen and probably will.

Americans tend to be overoptimistic about weapons. A case in point is the antitank field. In the 1930's the caliber .50 machine gun was to make the tank a "dead duck"; in 1941 it was the shaped-charge rifle grenade; before Korea it was the superbazooka and the recoilless rifle firing such charges, and the squashhead shell. None came up to expectations when used in battle.

Is the nature of the "new" really understood?

There is evidence that nuclear weapons are thought of as mere extensions of bombs ("bigger bang for a buck"), when it is increasingly evident that unique effects overshadow the blast.

Moreover the idea that nuclear and robot weapons can replace manpower may be the same error labor has made in fearing technological unemployment from mechanization and automation.

Finally it may be that electronics and new propulsion means should be used not to replace, but to supplement, man's mind. It's worth noting, too, that the "new" doesn't necessarily replace the "old" even if useful for the same thing. When readily available, gas still is used for heat and cooking, although electricity is newer. Nor has TV replaced the movies or the radio.

Actually it is most peculiar that America should swing so much toward the "new" in defense, when for her incomparable industrial greatness she relies so very much on the "tried and true."

The automobile industry, for instance, still is using the 4-cycle gasoline piston engine with components (carburetor fuel feed, spark ignition, water cooling) as introduced almost fifty years ago. Steel is made by the Bessemer process developed about a hundred years ago; the open-hearth process is 92 years old, and the blast furnace for making iron is even more ancient.

The first jet airplane flew more than fifteen years ago, and the first jet transport appeared seven years ago. However propeller-driven, piston-engined transports dominate the world's airways, and of the long-range transports on order as of last April 30th, 427 were piston-engined, 226 jet-engined, and 189 turboprop.

Douglas, for example (and 315 of the piston-engined aircraft on order are Douglases), has been able to "stretch out" its pre-World War II DC-4 design, into the postwar DC-6 and the DC-7C Seven Seas just coming into service. Wright, which supplies the engines, has "stretched out" the ancient piston type by the turbo-compound feature, offering extra power, speed, and economy in an engine thoroughly proven and familiar to world aviation.

The lessons taught by the case of the piston airliners apply equally to war or peace technology. One is that often there is plenty of "stretch-out" in the old, and this can afford in defense more and more reliable matériel for less effort and cost in research and development, manufacture, training, use—in fact, in almost every aspect.

M59's river capability proves inventive engineering can produce radical advances in conventional weapons at low cost (photo by Robert Phillips).

MILITARILY, these lessons were well demonstrated by Germany in World War II. Hitler, eager to take advantage of the latest in tank technology, kept putting into production the very latest things in armored warfare. The result was that the programs for new tanks were beset by production problems, and the tanks themselves were full of "bugs."

Thus while these tanks were greatly superior to the Allied ones *when they*

worked, they were always breaking down, and there were far too few of them.

It was the same with other weapons as with tanks. Hitler may have worried the daylights out of Allied authorities with the things he had in development and limited-service use, but the talent and facilities so expended on weaponeering that never really paid off in battle went far toward costing Hitler the war.

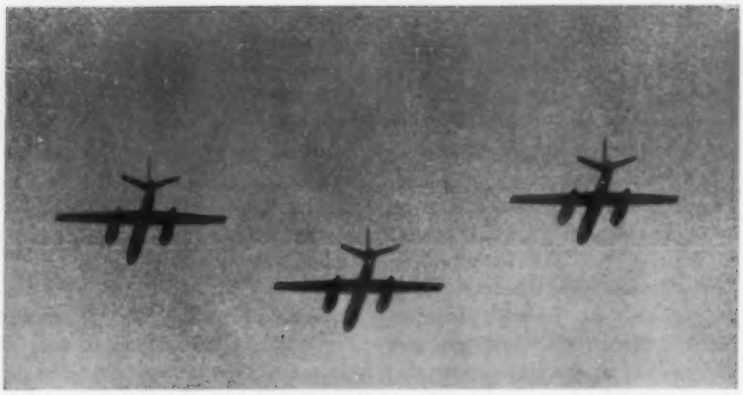
Very significant as an aid to defense thinking is the fact that the transport aircraft most used in commercial flying, both within the U. S. and behind the Iron Curtain, is the Douglas DC-3—a 1934 airliner that became the military workhorse of World War II and Korea as the C-47. It has maintained its standing, despite fifteen years' effort by engineers the world over to create a "DC-3 replacement."

Most important for proper appreciation of conventional weapon potentials appears to be an appreciation that "honest-to-God creative engineering" (as one Britisher has called it) no longer receives due recognition in an era in which the scientist rather than the inventor is revered.

YET history, including the most recent, has proved and reproved that it is invention that gives quick, cheap, and effective results. Usually it means a radical new concept for exploiting available scientific theory and proven engineering components. Of this the DREADNOUGHT battleship is an example: Italian General Cunibertti's concept didn't require a single new item but merely putting things together in a way that rendered all previous battleships obsolete.

In the case of the Soviet T34 tank the same thing was done—but the available proven components were put together according to a new theoretical approach to cross-country locomotion (dynamic load analysis).

James Hait of the Food Machinery and Chemical Corporation, furthered the same approach when in 1951 he altered the design of the original Lifesaver 20-ton armored personnel carrier into the M59 version which floats—a vehicle that appears to have changed rivers from military barriers into virtual highways.



Three Russian IL-28 light jet bombers fly by in formation. These ships are comparable to our B-57 Canberra bombers (*Life* photo).

To date, neither scientific research nor creative engineering has had any chance to get to work on conventional weapons with anything like the effort received by the new "superweapons."

The great creative period for America in the conventional weapons field was ended before World War I. Subsequently what little know-how there was remained confined almost entirely to the military, where it was hardly more than minuscule. Industry, of course, has had to follow the maxim "go where the money is," and "the money" hasn't been in conventional arms.

Nevertheless, what the Germans were able to accomplish in conventional arms (and despite Hitler's predilection for "gee-whiz" weapons), is an indication of what is possible. Today the Soviets are favoring conventional weapons not only for their direct combat value but also because such weapons can be designed to be made by commercial-type industries with standard-type tooling.

For example, examination of the MIG-15 jet fighter's 23-mm. cannon shows that engineers Nudelman and Saranov designed it so that it could be made in almost any well-equipped machine shop. Special tooling and entire new industries, such as often are needed for the new "superweapons," weren't required at all.

An important result of Soviet emphasis on conventional weapons, and on the simple "universal tooling" design they tend to employ, is that the weapons produced are of the sort fit for the minor nations which need arms either as satellites or cash customers.

A Russian-made SU-100 tank with 100-mm. gun rumbles by in Cairo parade. It is a sample of matériel furnished Egypt under arms-cotton trade with Russia (*Life* photo).

Egypt's recent deal exchanging cotton for Soviet tanks, guns, motor torpedo boats, submarines, and jet bombers and fighters is a very alarming sample of what can happen if America pursues her present policy.

Considering that peacetime psychological influences on small nations are most important (they can lose America an ally and orient neutrals toward the Soviets); considering that small nations can't afford most "superweapons" and couldn't effectively employ them with the conditions and manpower they have; and considering that such nations, being often backward in technology, don't understand the significance of the "superweapons" but can grasp that of improvements in the weapons they know, it seems vital that America reconsider its decision to neglect the conventional and concentrate on the "super."

THERE are many arguments why America should continue conventional weapons for her own defense, too. Some concern the actual direct value of certain such weapons. Other arguments must point out that, since in the past there has been imperfect understanding of certain arms classes with consequent unsatisfactory results, it is wrong to conclude that the "super" will inevitably be better than the conventional in these areas.

Aircraft guns constitute a case in point. Although the German Rheinmetall firm, as a result of operations research studies completed in 1934, recommended that 30-mm. cannon were needed, as late as 1940 U. S. Corps and Navy fighters had a virtual popgun armament of a couple of caliber .50 machine guns, sometimes supplemented by a pair of caliber .30 "peashooters."

THE 30-mm. cannon, which came into Luftwaffe service during World War II, only now are beginning to appear for U. S. and British fighters. Yet those who were "in the business" when Rheinmetall was right and U. S. very wrong are now presuming to say that the gun is a dead duck for air war and that it must be replaced by the missile.

That somebody is very wrong about current bomber armament is indicated by the contrast between the defensive armament of the U. S. and the Soviet jet bombers. U. S. theory has reverted to the pre-World War II idea that the craft will fly too high and fast to need much defense; hence only tail protection is afforded in the jet B-47 and B-52. But the Soviet Bison and Badger bristle with gun turrets providing protection from many angles.

The most powerful argument for conventional weapons is the very obvious one that they are essential, if only as insurance. They are needed in case the new weapons won't work the way they should or in case combat fails to afford time to find and adopt their most effective mode of use and to make modifications which practical experience may dictate.

Still another argument for the conventional is that it isn't always necessary, or even wise, to destroy people and property in order to attain the main object of military action—which is the destruction of the will to fight. By maneuvering into a position rendering it obviously foolish for an enemy to start or continue a fight, the fight can be ended. This is commonly done in Latin-American revolutions.

It was demonstrated on a major scale when the German 1940 blitz finished off France and the Low Countries in jig time, with little loss of life or property and without the main military forces of either side ever getting into shooting action. As a war technique, this type of blitz contrasts with that which "blows up the house to get rid of the termites."

Finally, it would appear that "superweapons" derive from the "nationalist" wars, which now seem of the past, when peoples were against peoples, nation against nation. The main war danger now is that of conflict between free peoples on one hand and Red tyranny on the other.

It is really political warfare, with the mass of the tyrannized not liking their rulers nor their way of life any more than the peoples they are forced to oppose. For such political warfare, what seems to be needed are types of weapons permitting the free peoples rapidly and effectively to come to the aid of the oppressed, not to wipe them out impersonally and unselectively—the dissatisfied along with the tyrants.

IT may be that the new jet transports, fleets of which will start being delivered in 1959 and which can carry a company of riflemen from America to the centers of Eurasia in a matter of a few hours, will furnish the potential means of getting "jet-age minutemen" swiftly to centers behind the Iron Curtain. With specially developed weapons (and those undoubtedly will be conventional) such troops even with light arms can support those who would prefer to revolt against their leaders rather than go to war for them but lack the arms. They can supply staffwork, leadership, and communications effectively to buck the network of tyrannical control.

Conceivably both the transport fleets and most of the "jet troopers" could be "convertible." The transports normally could be kept employed on commercial work and the soldiers in business but on the alert in the Swiss Army manner—with both airplanes and men on call at a few hours' notice. With such aircraft that will be easy, for no spot in the world will be more than a few hours distant from another.

Whatever the future of the conventional and the so-called "new" weapons may be, it is wise to bear in mind that now there may be potentials for really new weapons—ones especially suited to political-type warfare. These may possibly include the kinds about which America has often been warned by Maj. Gen. William M. Creasy, the U. S. Army's Chief Chemical Officer.

THESE are weapons which, instead of destroying men and things, will destroy temporarily their will and mental ability to act, permitting an aggressor to enslave the people and loot their riches—but also permitting liberators to free subject peoples without hurting them or the economies they have been enslaved to create.

EDITOR'S NOTE.—The photographs published here through the courtesy of *Life* magazine are copyrighted by Time, Inc., 1956.

Dispersal Is Good Defense

Our best passive protection against obliteration bombing is space, and space can be achieved only by an enlightened and intelligent program of dispersal of our new industrial plant while there is still time

Dr. Edgar A. Parsons

THE necessity for industrial dispersal has been apparent to all those who have addressed themselves seriously to the problem. The 1955 Review Committee of the report of Project East River recently made known the results of their analyses to Secretary of Defense Charles E. Wilson, Office of Defense Mobilization Director Arthur S. Flemming, and Federal Civil Defense Administrator Val Peterson.

The 1955 Review Committee, under the chairmanship of Maj. Gen. Otto L. Nelson, vice-president of the New York Life Insurance Company, was especially invited to analyze the existing dispersal policy in the light "of new weapons conditions" and "other serious hazards caused by fallout which need consideration." Over six months of study by the Committee resulted in a finding as follows:

"Industrial dispersion and reduction of urban vulnerability need reëmphasis, and additional implementing techniques on both the Federal and the metropolitan target zone levels are necessary."

Partly as a result of the findings of the 1955 Review Committee Report, the Air Force announced a new policy on industrial production readiness on December 28, 1955. Among other things, this policy stated:

"The production sources for Categories A and B systems (first and second priorities of weapons systems) will be analyzed to determine vulnerability and adequacy of dispersal. A program will be developed to minimize the loss of production of these systems through dispersal and other measures . . . (and) to the maximum extent possible, establish at least one source away from highly concentrated industrial areas and major military installations."

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THE purposes of the present article are (1) to itemize and to rebut the various reasons advanced for questioning a dispersal program; (2) to establish the military-economic factors that make a disperal policy necessary; and (3) to review industrial dispersal in the specific context of intercontinental ballistic missiles and residual radioactivity.

Inasmuch as the *Fortune* article, "Is Dispersal Good Defense?", by Messrs. Gershon Cooper and Roland N. McKean, has been frequently cited as a source of reasons for discounting the wisdom of a dispersal policy, it can serve here as a convenient foil. The reasons advanced therein for questioning the "goodness" of a dispersal policy have been loosely itemized, together with parenthetical comment as follows:

1. There are no "dispersal experts." (Why should this be material? We will become expert in this field as in atomic and missile technology by studied application.)

2. *Doubt* that dispersal would help "win" a war. (The basis for the doubt is not documented.)

3. *Possibility* that concentrated "conventional" plant sites at time of attack would make for greater total "capacity" than dispersed locations. (Depending on the site, the converse is equally possible.)

4. "Concentrated" locations are cheaper; *i.e.*, require fewer mains and rail extensions, reduce lags in replacing workers, provide better access to suppliers, permit economies of scale, etc. (These concentrations provide the enemy with his most rewarding targets.)

5. Changing over from a concentrated to some other locational pattern would entail abandonment of facilities. (That is, the dispersal program goes too far.)

6. The present national dispersal program provides for "war industries" only, and does not provide for dispersing consumer goods capital or personnel. (That is, the dispersal program does not go far enough.)

7. Most dispersal policies would re-

duce the quantity of preattack capital. (What are these policies? There is no policy known that would have the effect cited.)

8. If we reduced our present vulnerability, the enemy would simply "adjust his choice of targets to fit the altered location of our productive capacity." (A purely defeatist reaction that does not consider many problems of deliverability and U. S. defensive capabilities.)

9. Dispersal *may* not lessen, but *may* increase our vulnerability. (But no documentation was supplied for this speculation.)

10. Our present dispersal program "attempts to induce" and lacks power of compulsion; and there is no "inducement for 'nonwar' facilities to stay away" from the dispersed plants. (The dispersal program does not have teeth.)

11. To the extent that an enemy's targeting capability exceeds one hundred targets, there is little incentive to disperse. (This disregards many problems, such as forecasting the enemy's objectives when he selects *his* targeting system—what *we* might classify as target No. 181 might be No. 22 on the enemy's priorities list.)

12. Before adopting a dispersal policy we should know the size of the bomb the enemy will use. (Since when have enemies become accommodating?)

13. "The greater the concentration of our targets and of our defense against air attack, the greater the number of our fighters and Nike missiles that an attacking force *might* encounter." (The smaller the number of points to defend, the easier the defense—and against a ballistic missile?)

14. The enemy may be so ignorant as not to attack our most vital points; to make these vital points less vulnerable may therefore be a waste of effort and resources. (But should we depend on fighting an ignorant enemy?)

15. Dispersal *may* reduce our standard of living in terms of food, automobiles, housing, medical, and religious facilities and *may* also restrict our freedom of choice . . . an injured man may be better off in the hospital than at the scene of an accident, but we may kill him if we move him." (But a man injured that seriously will die for certain if left on the street.)

16. If we "grow stronger" we invite an aggressor to attack while we are yet relatively weak. (But can "weakness" be counted on to resist aggression?)

17. A dispersal program requires economic controls; economic controls are imperfect, necessarily arbitrary, and restrictive. (Should we, therefore, eliminate our dispersal program? And why stop at eliminating dispersal? Practically all Government activity depends on controls of some kind.)

Are we to damn a dispersal program whether it succeeds or not? Alternatives to a dispersal program were suggested as follows: (1) Education of more engineers and doctors for defense, (2) Give more money to our allies for their armed forces, (3) Make more A-bombs, (4) Expand and disperse SAC, (5) Build up active defenses, (6) Step up research on active defense, (7) Reënforce existing structures, (8) Construct new buildings, including putting them underground, and, (9) Stockpiling of strategic materials.

Without questioning the validity of these alternatives, it can be stipulated that they would reduce our vulnerabilities. Exception is taken, however, to the implication that any one or all of these nine points would justify elimination of a dispersal program.

The speculation and the mutually exclusive points advanced against a dispersal policy can be effectively rebutted by a review of some of the realities of life. The international-military aspects may be summarized as follows:

1. For many years, the Reds have engaged in an overt and covert campaign to impose their ideology and control upon all the countries of the world. This objective is being achieved by nonviolent means where possible and by force where necessary.

2. The United States has been foremost in encouraging resistance to international Communism. In the last two World Wars, the industrial might of the United States has brought victory to us and our allies.

3. The Reds and the U. S. possess A-bombs; both have experimented with thermonuclear bombs.

4. Defensive capabilities of fighters and missiles are insufficient to guarantee security from attack by manned or pilotless vehicles armed with area-type weapons.

A SIMPLE relationship is pointed up by this political-economic-military environment. The strategic mission of the Red air force is undoubtedly the destruction of the industrial and retaliatory might of the United States. The number and kind of targets nominated by the Red counterpart of our Strategic Air

Table I. Estimated capital replacement costs for major manufacturing industries by fifty-three standard metropolitan areas in the United States.

	Millions of Dollars	Per Cent of U. S. Total
Food products	$10,042.9	49.8
Tobacco manufacturers	815.2	29.2
Textiles	2,688.8	31.1
Apparel	3,036.7	70.2
Lumber and products	349.1	13.7
Furn. and fixt.	1,105.2	49.0
Paper and products	2,028.9	45.1
Printing and publishing	4,602.1	71.5
Chemicals	9,253.8	58.5
Petroleum and coal products	9,285.4	62.6
Rubber products	1,758.5	67.9
Leather products	794.0	41.4
Stone, clay, and glass	1,409.9	43.6
Primary metal industries	20,919.8	72.3
Fabricated metal products	8,381.5	71.9
Machinery (except electrical)	9,159.8	65.9
Electrical machinery	5,527.4	76.6
Transportation equipment	10,807.3	76.2
Instruments and related products	1,103.2	79.3
Miscellaneous manufacturers	2,373.0	73.0
	$105,442.5	61.8

Command determine the number of area-type weapons required by the Communists and the number of carriers required to deliver these weapons.

It would be fortuitous, indeed, if the normal arrangement of resources for war and peacetime production should coincide with their most effective distribution for survival from enemy attack. Such a propitious arrangement might entail prohibitive risks and expenditures on the part of the Reds. The burden of these costs for the Soviets might be gauged by our own U.S.A.F. budget of some $15 billion a year.

Examination of any world map that shows our vast network of overseas air bases will show how small the present SAC mission is, compared with that of the Reds' long-range air force. To the extent that a dispersal program magnifies the risk of a would-be aggressor, dispersal clearly contributes to the security of the United States.

A FEDERAL Civil Defense Administration research project investigating the "coincidence of industry and population targets" determined that the desired ground zeros for maximum population casualties and the desired ground zeros for maximizing destruction to "war-supporting industries" coincide to a high degree.

The available data on twenty-seven major urban areas indicate that a single aiming point somewhere between the respective optimum ground zero for population and war-supporting industry would tend to accomplish both objectives. Specifically, in 17 of the 27 cities, the average would be more than 80 per cent; in 10 of the 27, the average would be more than 90 per cent. In only one area would the coincidence be less than 60 per cent.

It is reasonable to expect a high degree of physical property concentration in highly populated areas. Based on general property replacement costs and using 1953 prices, the total replacement costs for all property at risk in the United States as of 1950 approximated $1,236 billion. This excludes agriculture, mining, public works in rural areas, and a large part of the railroad and public-utility property outside the cities. Of the total of $1,236 billion, 53 per cent, or $653 billion, is contained in 70 metropolitan areas regarded by the FCDA as "critical" target areas. The 1950 population of these 70 metropolitan regions totaled 67,750,982.

	Millions of Dollars	Per Cent of U. S. Total
Chemicals	$ 6,704.6	42.4
Petroleum and coal products	7,582.8	51.1
Rubber products	1,444.3	55.7
Primary metal industries	14,545.2	50.3
Fabricated metal products	5,147.1	44.2
Electrical machinery	3,816.8	52.9
Transportation equipment	7,674.3	55.5
Instruments and related products	921.9	66.2
Miscellaneous manufacturers	1,710.5	52.6

Table II. Estimated capital replacement costs of selected industries in ten highest ranking metropolitan areas throughout the United States.

It may be argued, however, that an enemy strategist would be more concerned with the degree of concentration of *specific* industries rather than industry in general. Bombing of any *one* industry would give the Soviets a destruction bonus of many other industries. Table I shows how destruction of 53 areas would reduce our total production capacity to the level of a fourth-rate world power!

Our excessive concentration can be underscored by reference to Table II, which shows the estimated capital replacement costs of selected industries in ten metropolitan areas.

Each of the industries has a different locational pattern, yet ten successfully delivered area weapons would deprive the United States of major fractions of vital industrial capacities. A dispersal program would force the enemy to send out much more striking power to achieve his objective.

Since World War II, the U. S. has expended some $60 billion ($1,300 per U. S. family) in various forms of foreign aid. Current defense expenditures are about $35 billion a year (or $750 per family). This sum may purchase protection for the moment, but should we not be more concerned with means of obtaining *permanent* protection? Our objective is to reduce our vulnerability. This can be effected in ways other than the purchase of short-lived interceptors of uncertain effectiveness. Dispersal is one way of cutting this expense.

Three additional factors favor dispersal of industry: (1) the threat of intercontinental missiles, (2) residual radioactivity (fallout), and (3) the probable extent of destruction in a nuclear war.

The advent of an operational intercontinental ballistic or other type missile is revolutionary in both active and passive defense. Defensive counters to the ICBM such as the repositioning of probable military objectives, the development of a mobile offense, and other active defense measures are outside the scope of this paper.

Suffice it to state that the ICBM is bringing the science of destruction to the level of being able to destroy any immobile target in the world that can be located.

It may be cheaper for an enemy to fire a half dozen relatively inaccurate missiles at a metropolitan area than to design an expensive pin-point guidance system into a single all-important missile. The possibility of ICBM's fired in salvo suggests that the less dangerous dispersal sites for new plant construction are located tens of miles from probable aiming points.

THE mystery of fallout has become less baffling since Admiral Strauss, Chairman of the Atomic Energy Commission, made his public announcement of February 1955. Fallout was therein described as being lethal over a cigar-shaped area of some 20 miles by 200 miles, depending on wind, bomb yield, and detonation proximity to the ground. The total area of danger was considerably larger, measuring some 7,000 square miles.

Immediately after detonation, the casualty-producing characteristics de-

crease rapidly. Thereafter the decrease is at a declining rate. Dr. Willard Libby, AEC Commissioner, describes the decay as follows:

"The mixture as a whole decreases in radioactivity in such a way that for every sevenfold increase in age, the radioactivity is decreased tenfold. Thus the radioactivity by 7 hours after the explosion has decreased to 1/10 the radioactivity at 1 hour; at 49 hours (roughly 2 days) to 1/100; at 2 weeks to 1/1000; and at three months to 1/10,000 . . ."

Unfortunately, the casualty-producing properties of fallout are so severe as to make one wish the decay rate were greater. The test shot of March 1, 1954, exposed many Marshall Islanders to fallout. Twenty months later, the affected areas had not cooled sufficiently to permit resumption of all normal life.

Fallout is unpredictable. Although prevailing winds in the United States generally blow in an easterly direction, there is not much confidence that on any given day fallout will be deposited along a particular axis of prevailing wind direction.

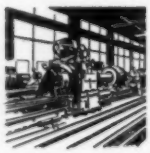
Further, there is no basis for assuming that only one bomb will be aimed at a specific target. Logic and past experience seem to indicate that important targets will be bombed by several aircraft or missiles in order to increase the probability of destruction.

Because thermonuclear weapons are capable of wreaking unparalleled devastation, it has been argued that dispersal of industry is unnecessary, as a decision would probably be made manifest in a matter of days and a war's duration probably will be so limited as to make negligible any war matériel contributions from the industrial economy. Destruction and timing, it is said, will limit combat to that supportable from D-day stocks on hand.

BUT there are other equally compelling reasons for dispersing facilities besides protecting a war mobilization base or ensuring continuity of essential war production.

First is the survival, and later the maintenance, of the civilian and military population. Thermonuclear war is totally incomparable with any catastrophe experienced in history. The civil defense exercise known as "Operation Alert," held in June 1955, was widely criticized for using relatively "small" bombs. The official FCDA assessment stated that over 16 million persons would have died as a result of these "small" bombs, and approximately 25 million people would have been made homeless.

These two figures account for one out of every four living Americans. The medical and survival requirements of such a disaster would demand the full utilization of whatever population and resources survive the initial attack.



Dispersal of industry is related to the problem of caring for the civilian population. A dispersed industry will tend to cause a dispersal of population. Labor is one of the factors of production and, if experience is a guide, will locate close to the place of employment. This will naturally attract the necessary consumer and service industries.

Because of dispersal, the probability of survival is increased. By putting space between existing industrial concentration and new plant construction a dispersal program accomplishes two objectives: (1) It limits the number of people and amount of industrial capital capable of being destroyed by a single weapon, and (2) it increases the absolute number and proportion of people and resources that will probably survive an attack. This will ease the tremendous task of caring for the millions of injured and homeless.

In the postattack period, our most precious resources may well be the homes and associated community floor space (restaurants, schools, stores, public buildings) in small towns adjacent to the bombed areas. These surviving resources will be the only available means of caring for the victims.

> *"It may be cheaper for an enemy to fire a half dozen relatively inaccurate missiles at a metropolitan area than to design an expensive pin-point guidance system into a single all-important missile. The possibility of ICBM's fired in salvo suggests that the less dangerous dispersal sites for new plant construction are located tens of miles from probable aiming points."*

Bombs destroy ownership rights and may cause bankruptcy. Area-type weapons destroy assets, not liabilities. The assets destroyed are of two types: (1) the on-site plant and equipment, and (2) the accounts receivable represented by IOU's of widely scattered corporations and individual enterprises. The loss of centralized accounts receivable may be more disastrous financially than the loss of the central plant.

A decision to discount the advantages of dispersal in new plant construction is one that aggravates the uncertainties of our times. In the postattack period it may destroy our political-economic society by creating two classes: one bombed into poverty, the other little, if any, damaged. Such widely different interests do not bode well for the restoration of the preattack political and economic status quo. Dispersal contributes not only to postattack corporate solvency but also to the postattack continuation of prewar status and political relationships.

Our military policy is massive retaliation. This clearly means we must plan to expect and to absorb the first blow of an enemy. A prudent and calculating enemy will certainly not strike unless he is confident of neutralizing the United States. Modern weapons give him this capability.

MASSIVE retaliation may then destroy the enemy, but with millions of people killed and injured, and millions of others made homeless by fallout, will we be able to survive as a nation? No one can say for certain. Our chances of survival can be increased by heeding the advice of the Government to locate our $28-30 billion of *new* plant and equipment in nontarget areas. Despite thermonuclear weapons and fallout, our best passive defense against obliteration is space, and space can be achieved by an enlightened and intelligent progam of dispersal of our new plant and equipment. There is no satisfactory alternative.

Armament for National Survival

Theme of the Thirty-eighth Annual Meeting of the

American Ordnance Association

to be held at

Aberdeen Proving Ground, Md.

Thursday, October 4, 1956

MEMBERS of the A.O.A. will be guests of the Ordnance Corps of the United States Army at the world's greatest proving ground to witness current tests and demonstrations of the latest ordnance equipment produced by the Industry-Ordnance Team. Many of the newest weapons of the armed forces will be described and fired.

● The program will begin at 10:00 a.m. Eastern Standard Time and will conclude at 3:30 p.m. Only members of the American Ordnance Association holding tickets will be admitted. Tickets entitle each member to a seat in the stands, a printed program, and luncheon. Any surplus of proceeds over Association expenses will be donated to the Army Relief Society.

● There will be special trains directly into the Proving Ground on October 4th. These will leave from Washington, Philadelphia, and New York and will return immediately after the conclusion of the program. Some Posts plan to run special cars to Aberdeen, and many members will come in private aircraft. Clearance must be secured for the latter from Operations and Training, Aberdeen Proving Ground, Md., one week in advance. There will be ample parking space for private automobiles.

● Complete information, train schedules, and reservation forms were mailed to all members on August 3rd. Reservations will close on Wednesday, September 26, 1956.

Underwater Research

The British laboratory at Teddington is probing undersea ballistics with such new devices as water tunnels, a rotating beam, and a water-entry tank to develop more powerful and effective air and sea weapons

Jules Menken

ABOUT fifteen miles west of London in Bushy Park—but taking its name from the adjoining town of Teddington—the visitor interested in naval matters will find a fine block of modern buildings, one of them roofed by a low dome larger in diameter than the dome of St. Paul's in London or St. Peter's in Rome.

This block, which was completed with its plant in running condition in August 1954 and first displayed for public description in November 1955, houses the British Admiralty's new laboratory for underwater hydrodynamic research.

As with most large enterprises, a number of elements entered into the conception and plan of the new Teddington laboratory, including some completely novel equipment the like of which does not exist elsewhere. One element was the extensive experience of the Second World War, in which submarines, water-launched and air-launched torpedoes, and aimed and guided bombs were either newly developed or employed on a previously unexampled scale.

A second element was the development of new alloys, refined engineering methods, and new propellants hydrogen peroxide is one example) which made possible prolonged submergence and underwater speeds that had previously been unattainable.

A third element was the remarkable advance in aërodynamic research achieved in recent years, which has not been paralleled in the sister field of hydrodymanics, where the existing state of knowledge therefore appears to offer promising possibilities of major advance.

Still another element was the availability of scientists trained in the general concepts and techniques of fluid dynamics—which, from the research standpoint, includes both aërodynamics and hydrodynamics.

A final and most important factor was the overriding necessity, which postwar financial pressures repeatedly drove home, of using all available defense resources with the greatest attainable efficiency.

A systematic program of hydrodynamic research requires suitable experimental equipment to carry it out. What is needed in turn depends largely on the problems to be studied. For the purposes of Admiralty research at Teddington these fall broadly into three categories.

One group comprises such problems as the reduction of drag with bodies of different hydrodynamic shape, the yaw, roll, and lift forces involved when such bodies change direction, the turning-moment forces required to bring about or offset such changes (and, therefore, the size, hydrodynamic form, and placing of the apparatus producing or countering such forces), and the effects of depth.

A SECOND group of problems includes measurement of the characteristics affecting stability and control of underwater bodies and the general investigation of such bodies when traveling at very high underwater speeds of the order of 100 knots.

A third group concerns the many weapons which start their journey in the air, enter the water, and then travel under water to their targets. With this group the major research problems include the phenomena of water-entry both generally and as affected by different aërodynamic and hydrodynamic shapes.

In aërodynamic research one essential tool is a wind tunnel. In hydrodynamic research an exact analogy and corresponding need is a water tunnel. The first group of problems outlined above is suitable for water-tunnel re-

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search, with the model stationary, the water flowing past it, and water speeds and pressures at the model variable over a wide range.

With the second group of problems different requirements arise. In the study of stability and control, motion along curved paths must be considered as well as motion in a straight line. For this purpose a rotating beam which can move models fixed to it through a ring-shaped (or annular) channel is eminently suitable.

When studying high-speed underwater bodies, a straight path which eliminates centrifugal effects is desirable; but for obvious reasons—among them feasible size and convenience in taking readings—a rotating beam and an annular tank are the only practical choices. As regards the third group of problems, the essential research tool is a water-entry tank with the necessary equipment.

Given these requirements, when the plans for Teddington were settled four pieces of major equipment were finally agreed on. They comprise two water tunnels—one with a 12-inch and the other with a 30-inch working-section—a large rotating beam capable of achieving high underwater speeds and an associated annular tank or channel, and a water-entry tank.

Besides these main components, together with the necessary instrumentation, the new laboratory includes a general office and laboratory block, plant rooms, filtration equipment, transformer switch gear, etc.

A WATER tunnel is a device enabling water in a closed circuit to be pumped at various speeds and pressures past models fixed in a working section. Besides a high-capacity pump, piping, and a working section in which models can be mounted and observed, the essential features include a control system which enables the velocity and pressure of water in the working section to be varied over a wide range and instruments which make possible the measurements required in any given experiment. It is often necessary also to control the temperature and air content of the water in the system.

Control of the air content is especially important when studying the phenomena of high-speed flow associated, for example, with cavitation—a state in which vapor bubbles form because the local velocity of flow is so high that pressure is reduced locally to vapor pressure.

In a closed-circuit tunnel the bubbles released by cavitation tend to flow round the system, altering conditions in the working section and hiding the model placed there. With an appropriate combination of pressure and time, however, the bubbles are reabsorbed into the tunnel water.

This fact has been utilized by Prof. Robert T. Knapp, of the California Institute of Technology, in devising what is known as a "resorber"—essentially a part of the circuit in which water moves very slowly and under pressure while the bubbles are reabsorbed before the stream passes on again to the working section.

When planning the Teddington water tunnels a very difficult problem arose from the relationship between the size of models requiring study and the diameter of the working section. The source of the problem is the behavior of what are called the boundary layer and the static pressure.

In fluid mechanics the boundary layer is the layer of fluid (in this case, water) whose velocity is reduced because of its contact with, or nearness to, any solid body over which the fluid is flowing.

In a working section with solid walls which totally enclose the jet of water flowing through the tunnel, the thickness of the boundary layer increases throughout the length of the working section and results in a corresponding change of static pressure. Large allowances in the measurements recorded during tests must be made for these factors whenever the diameter of models exceeds about one-sixth of the diameter of the jet in a closed working section.

But such a limitation would make it necessary to keep models too small for many of the problems to be studied. For example, a power-driven model torpedo with propellers to scale might be about eigh inches in diameter, which would make it too large for use in a conventional working section thirty inches in diameter, with solid walls and a closed jet of water. For various reasons the alternative of an open-jet working section was not regarded as desirable.

THE solution devised at the new Teddington Laboratory is to pass the jet of water through a cage of perspex bars with slots between them set longitudinally along the working section and surrounded by an outer chamber 2½ times the diameter of the jet.

The wall of the outer chamber is the wall of the working section. With this device the boundary layer is automatically drawn off through the slots, speeds of flow in the outer chamber are very slow, and static pressure in the working section is virtually the

The rotating beam channel at Teddington with model in place for underwater testing. Antiswirl barriers can be seen, but the water is too clear to show in photo.

same as in the outer chamber and very nearly constant even for very long working-section lengths—a state corresponding to that of a free-running body (like a torpedo in action) which, of course, is the object of real interest.

Thanks to the slotted wall, the working section can test bodies with twice the maximum diameter that could be tested in a conventional solid-wall working section.

The 12-inch water tunnel was designed to serve as many purposes as possible and was made with three interchangeable working sections comprising a conventional closed jet 3 diameters long, a slotted wall (and outer chamber) 6 diameters long, and an open jet some 1¼ diameters long for propeller testing.

A NOZZLE with a nine-to-one contraction ratio leads into the working section. This nozzle is based on the design of the nozzle in the Garfield Thomas 48-inch water tunnel at Pennsylvania State University. A short transition section follows the working section and is followed in turn by a conical diffuser leading to the first bend where the area is four times that of the working section.

All bends in the tunnel circuit except the pump bend are right-angled cascade bends similar to the type used in wind tunnels and made so that they can be adjusted should the flow not be turned through a true 90-degree angle.

The water speed can be varied continuously up to about eighty-two feet a second (about forty-nine knots) in the closed working section, and up to rather lower speeds in the slotted-wall working section.

At the same time the pressure in the working section can be raised from about three pounds per square inch to forty-five pounds per square inch absolute. Pressure is controlled by varying the air pressure on the water surface of a cylindrical vessel placed at the highest point in the tunnel circuit.

Provision is made for temperature control, refrigeration, and water filtration. Refrigeration is necessary at high speeds of flow because of the large power-input into a comparatively small amount of continuously circulating water.

The 30-inch water tunnel is capable of testing powered models ten inches in diameter containing about 100 horsepower and fitted internally with measuring equipment. It is an essential complement to both the 12-inch water tunnel and the rotating-beam channel.

The main tunnel circuit is about 77 feet long and 33 feet high, and there is also a resorber section some 50 feet deep. The hydrodynamic circuit of the water tunnel holds nearly 240,000 United States gallons when full. The contraction nozzle, the transition section, and the conical diffuser are similar to those in the 12-inch tunnel.

The slotted-wall working section has a jet diameter of 30 inches and a total length of 18 feet, while the outer shell has an external diameter of about 8 feet. The slots between the perspex bars are set at right angles to the windows in order to reduce optical interference and provide better conditions for observation. The slots constitute about twenty per cent of the periphery of the working section.

Models may be mounted on two jacks set in streamlined struts fixed to the bottom of the working section and capable of movement so as to adjust the position and incidence of the model while the tunnel is running.

The speed of flow in the working section is continuously variable up to 60 feet a second (35 knots), and the pressure can be varied from about 2 to 45 pounds per square inch.

THE rotating-beam channel comprises a large annular channel surmounted by a rotating beam, the whole being housed in a building with certain special structural features. The photo on page 243 shows the general appearance of the channel, the rotating beam, and the domed roof.

In form the channel is a large ring-shaped tank with a rectangular cross-section. The inner wall has a radius of 34 feet and the outer wall a radius of 68 feet. The channel is 34 feet wide, and with a maximum water depth of 15 feet and an 18-inch freeboard its capacity is roughly 1,200,000 United States gallons.

The structural features include two observation chambers situated opposite each other, one in the inner wall and one in the outer wall; a 5-foot walkway around the outside of the channel; an immensely strong containing wall of heavily reënforced concrete 3 feet thick; and a shallow dome 156 feet in diameter with a double skin and other arrangements to ensure that the roof is watertight and thermally well insulated.

The rotating beam itself is essentially a stressed-skin construction 122 feet long with a cross section at the ends 6 feet 8 inches wide and 3 feet 4 inches deep.

VERY severe requirements were specified to ensure adequate stiffness—which is essential for experimental purposes—and under test conditions limits of not more than 5 minutes of angular deflection in the pitch and yaw planes and of under 12 minutes' deflection in roll were met.

The beam rotates around a massive hollow kingpost which rests on a heavily reënforced concrete bed sixteen feet thick and was carefully set up so that the axis of rotation should be as nearly vertical as possible. In fact, a figure of within 8 seconds of arc—or less than one forty-thousandth part of a right-angle—was achieved.

The moving part of the beam weighs about sixty long tons, and the maximum speed of rotation is approximately one revolution every two seconds. Models can be mounted at either end of the beam in any one of three positions respectively 45 feet, 50 feet, and 55 feet from the center.

With the beam rotating at maximum speed, a model at the 50-foot radius has a speed of about 150 feet a second, or just about 100 knots at the 55-foot radius.

Test models may be as large as a full-size torpedo (*i.e.*, up to twenty feet in length and twenty-one inches in diameter), though much work, particularly on stability, will be done with models half this size. In planning and conducting tests many problems arise. Since models may weigh more than

2,000 pounds (and with the strut which supports them from the rotating beam up to 3,000 pounds), some problems concern their means of support.

For example, the strut must be strong enough but with low hydrodynamic drag, small wave-making properties, and unlikely to cavitate at top running speeds.

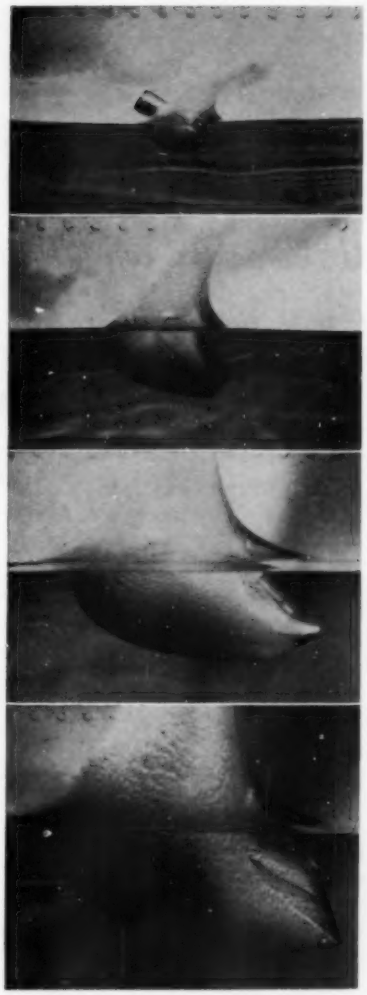
Again, models must often travel around the channel under their own power, which means that the beam and strut must be rotated at exactly the same speed as the model itself is traveling. Yet again, when studying high-speed underwater motion in a circular path the longitudinal axis of the model will have to be curved to the running radius in order to minimize yaw effects.

THE movement of the model and strut tend to stir up a mass of water in the annular channel in a general motion called swirl. Because of related water disturbances, swirl must be kept down to a minimum. A system of anti-swirl barriers (the appearance of which can be seen in the illustration on page 243) has been devised which reduces swirl by about four-fifths; *i.e.*, to just over one per cent of the speed at which the model is traveling—a very low value indeed.

Another problem concerns wave formations and associated resonance effects caused by the movement of the strut through the surface of the water. Shallow sloped beaches fitted at the top of each channel wall have largely disposed of these difficulties. Yet another problem concerns the turbulence level of the channel. Since tests show that this is low, it may be possible to use the channel for laminar flow studies.

The need for water of exceptional clarity in order that high-speed photographs may be taken creates further problems largely concerned with filtration. Measured over a 2-meter length in terms of optical transmission per meter, the channel water can be maintained at a clarity of 89 per cent that of air.

EARLIER research facilities for the study of the water-entry characteristics of missiles which start their course in the air and continue it under water have been replaced by the new installation at Teddington. This installation, which is housed in a specially designed building, comprises a water-entry tank for launching models two inches in diameter, a catapult for launching them, and arrangements for very high speed photography.



The sequence of multiflash photos, above, records a typical water entry of a test missile. All pictures are same scale.

The water-entry tank is 29 feet long, 9 feet deep, and 5 feet wide and is mounted over a sump in the floor capable of holding all the water in the event of breakage. Both of the long sides are glazed with the largest available toughened glass panels. The high-speed photography facilities include ciné-flash mercury-vapor lighting units which can be flashed on for periods long enough for the complete water-entry of the projectile under study to be recorded.

MISSILES released from aircraft tend to enter the water under a variety of conditions and in general at the instant of entry are pitched and yawed off the line of actual entry. For studying such off-trajectory shots it has been found best to fire models into the tank from a catapult with a carriage.

For this purpose a special small slotted-cylinder compressed-air catapult is used. This catapult is similar to the steam catapult for launching aircraft from carriers and has been developed by the same designer.

The over-all length of the catapult is 13 feet, of which 9 feet are used for the acceleration stroke and one foot for hydraulic retardation.

The catapult is mounted on a variable-angle platform, which, with the structure of which it forms part, is so arranged that models can be fired into the tank at any entry angle between practically horizontal and vertical. With a view to easing the photography and subsequent analysis, other arrangements ensure that the projectile always enters the water at about the same point. The pictures on this page illustrate a typical sequence of water-entry photos.

THE problems actually under study at Teddington are naturally subject to strict security. Their general nature in terms of physics has already been indicated. In terms of weapons, experience during the last war indicates what some fields of interest are likely to be. In the case of torpedoes they include streamlining, depth control, and water entry; while with antisubmarine mortar bombs many questions of form and angle of entry are included in the problem of obtaining optimum shape.

More exciting for those with a bent for speculation is the question: What types of underwater bodies can approach speeds which make desirable the 100-knot test facilities available in the extreme position on the rotating beam? What is certain is that when this question can be answered very notable advances in hydrodynamic research and practice will have been achieved.

Airpower Needs Manpower

Unless the Strategic Air Command can keep its skilled technicians for longer periods it will lose its high state of efficiency and the Nation will lose its air supremacy in this vital defense area

Joseph Goodyear

SEVERAL months ago at a Strategic Air Command base an airman scrambled into the cockpit of a T-33 jet trainer for a routine instrument check. Suddenly the emergency ejector seat mechanism went off and the airman was flung high into the air to come smashing to his death on the concrete.

Why did the accident accur? The crew chief had overlooked certain safety measures that could have prevented it, and further investigation disclosed that the crew chief—who is responsible for the airworthiness of a complex jet aircraft—was green—he had been out of tech school only two months.

When word of the accident reached Gen. Curtis E. LeMay, SAC Commander in Chief, he immediately sent for the wing commander for an explanation as to why he had entrusted a T-33 and the lives of the ground and air crew to a relatively inexperienced man.

On the carpet, the officer listened as General LeMay outlined in no uncertain terms the responsibilities of a wing commander. The wing CO said nothing until the general finished and then he said simply: "General, that crew chief was the best man I had."

His answer underscores what is probably the most pressing problem facing the Strategic Air Command—in fact, the entire Air Force—today—the growing shortage of skilled manpower.

Mr. Goodyear is an aëronautical journalist and a frequent contributor to ORDNANCE. *His articles have also appeared in the* Journal of the Franklin Institute *and in other industrial publications.*

There has been much blazing newspaper copy about the relative merits of our B-52 and the Soviet Bison, or whether or not we are matching the Reds in the missile race, but scant attention has been paid to the urgent manpower problem. The problem is not a theoretical one—it is real and it is imminent. For example:

1. The number of Strategic Air Command bases in the United States has increased 77 per cent since January 1953; the number of combat wings is up 38 per cent; refueling squadrons are up 135 per cent; yet this expansion has been met by a personnel increase of only 23 per cent. Result: *SAC is undermanned.*

2. By the end of 1956, only nine per cent of SAC's airman strength will consist of men with more than four years of service in SAC. The experienced men, therefore, are spread thin throughout the Command. Result: *SAC efficiency is dropping.*

3. Approximately 75 per cent of SAC airmen in direct support fields leave when their 4-year enlistment period is up. Just to replace those men who left in fiscal 1955 cost the Government an estimated $777 million. Result: *Money supposedly budgeted to strengthen our air power must be spent merely to maintain the status quo.*

4. More than 70 per cent of the aircraft commanders at SAC are in the 30-38 age group—men with real experience. Their replacements should come from men in the 24-26 age group but will not because it is from this group that the fewest number remain in the Air Force. Relatively inexperienced men must, therefore, take over in a few years. Result: *Our greatest advantage over the Soviets—superb fliers —will soon be lost.*

SAC conducted a survey to determine what effects these factors are having on *present* operational efficiency. The two SAC combat wings that were weakest in skilled personnel (only sixty-six per cent manned in direct-support skills) were compared with the two best manned (eighty-five per cent). All four wings were fully manned numerically.

The study showed that the 2 poorest-manned wings had completed only 80 per cent of their required flying time as against 99 per cent for the best-manned wings, and because they flew fewer hours despite certain fixed costs it actually cost SAC 10 per cent more to train the poorer wings. Furthermore, only 75 per cent of the training accom-

plished by the poorest-manned wings was acceptable, as compared with 91 per cent for the best-manned wings.

The most significant comparison, however, was made during simulated combat missions when the study showed —and practice bombing evaluation is electronically accurate—that the poorest-manned wings were twenty per cent less effective. In other words, one target in five would be missed in wartime.

Why are these conditions allowed to exist in the most important unit of our armed forces?

SAC's manpower problems can be traced, in virtually every instance, to one factor—the low rate of retainability. SAC men finish their 4-year enlistment period and leave the service. Only a few, too few, stay on for another hitch. Then a new group must be trained to replace the men who have left.

The training in technical fields is completed only 18 months before the 4-year enlistment period is up; SAC technicians, therefore, are productive only for 37 per cent of their enlistment period. Unless SAC can keep its men for a longer period, it will lose its operational efficiency, and the Nation will lose air supremacy. This is the crux of the problem.

Why retainability, which is certainly a problem in any military force, should be a life-and-death matter for SAC can be better understood when the structure and organization of the Command is examined.

The Strategic Air Command is unique, particularly in a democracy, in that it must be at peak wartime strength every day, *in peacetime*. It is therefore deprived of the many strengthening factors that are available in war, such as high morale, unlimited manpower, and generous appropriations. Yet SAC must operate as if it had all these things.

SAC is big. It is the largest single air major command in the United States and utilizes roughly one-fifth of the entire Air Force strength in officers and airmen. SAC maintains, in addition to a network of U. S. bases, twenty-one overseas bases and three overseas Air division headquarters. About eleven per cent of the total SAC personnel are in widely scattered SAC bases overseas.

SAC is complex. It is an air force in itself, with its own bombers, fighters, reconnaissance and cargo aircraft, tankers, and trainers. A typical B-47 Air division includes two B-47 wings, an Air division headquarters, and an Air base group to support the wings.

Each wing consists of three tactical squadrons, each operating fifteen B-47's; one air-refueling squadron of twenty KC-97 tankers; one periodic-maintenance squadron; an armament and electronics squadron; a field-maintenance squadron; and a tactical hospital. The Air Base Group is made up of six squadrons (operations, food service, installations, Air police, motor vehicle, and supply) and a hospital.

SAC is costly. It is a credit to the Command that despite its size and organizational complexity, only three per cent of its personnel are in "overhead" jobs; the rest support the fifty-one combat wings. Nevertheless, the cost of maintaining this force with its complex equipment is staggering.

Over a 5-year period, for example, SAC invests $600,000 in just one B-47 combat-ready pilot, and in a 4-year period $22,500 for an airman technician.

SAC is in a constant state of change. It is a fluid and dynamic organization. It cannot remain static and hope to match the Communist challenge. It must phase out the obsolescent B-36 in favor of the all-jet B-52 without sacrificing striking power during the transition; and it must eventually replace the sluggish KC-97 with the speedy all-jet KC-135 tanker. Furthermore, SAC must continually rotate its overseas force, adding to the general personnel instability.

A force as unique, as big, as complex, and as dynamic as the Strategic Air Command obviously requires many men with many skills—and for a longer period than four years. SAC feels it can hold its own only if: (1) A career in the Air Force is made more attractive; (2) Equipment and maintenance are simplified; (3) Airmen are signed up for a longer period than four years; and (4) Recruiting is more selective.

The most important point is the first —if an Air Force career can be made more attractive, airmen will stay on when their initial enlistment period is completed.

WHY don't airmen reënlist? Basically, civilian life offers more, both financially and socially. There is little need to quote comparative salaries between industry and the military for similar jobs. The average man, considering both officers and enlisted personnel in a SAC Air Division, makes $340 a month. On the basis of payroll

With few skilled technicians like this team at Castle Air Force Base reënlisting, the manpower shortage in SAC has become a major problem (Air Force photo).

versus capital investment, SAC puts $740 or 7.4 per cent into payroll for every $10,000 in capital investment (equipment, real estate, etc.). Compare this with General Motors, for example, which put $6,000 or 60 per cent of its asset value into salary on the same basis.

On the social level, airmen and officers alike found little—until recently—to induce them to stay in the Command and raise a family there. Housing, dependents' assistance, and instability were such as to discourage any but the most hardened careerist. This is changing somewhat, but it still has a long way to go.

IN 1951 when airman strength was about 113,000, the force was composed largely of career men and Reservists and National Guardsmen who were trained during World War II. By the end of this year, however, this original force of 113,000 will have dwindled to a mere 13,000. Their replacements, men who came in in 1952-1954 and who are primarily in their first enlistment, will soon have the option of reënlisting or leaving. By the end of 1956 SAC will have a force of 170,000 airmen—and only 15,000 of them, 9 per cent, will have more than 4 years' experience in the Strategic Air Command.

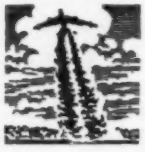
A similar situation exists on the officer level. SAC is currently only about 90 per cent manned against its requirement of 29,160 officers. The officer group is made up partly of career Reservists (54 per cent), men who came into the Air Force in World War II and who can be expected to stay; Reserve officers with separation dates (31 per cent) who came into the U.S.A.F. from Officer Reserve Training Corps units in colleges and who will in most cases return to civilian life at the first opportunity; and Regulars (15 per cent).

THE career men are the backbone of SAC, but they can't carry the load indefinitely. Some 70 per cent of aircraft commanders are between the ages of 30 and 38. When does a man get too old to fly a 600 m.p.h. jet bomber for 10 to 20 hours? If the younger fliers, the Air Force R.O.T.C. men, leave after their initial enlistment period, where are experienced replacements to come from? Today SAC's pilot pool consists mostly of men with long experience. In a few years there will be only a handful with this kind of background.

What, then, is being done, if anything?

Some steps have been taken—but only a few steps where long strides are needed. The changes, primarily in terms of making the SAC career more attractive, have been made on three separate levels—by SAC itself, by the Air Staff and the Department of Defense, and by the Congress.

SAC's own program, the goal of which is the recognition of the airman as an individual rather than merely as a cog in a military machine, has included the establishment of a dependents' assistance program; a minimum 2-year tour at one station to permit a more stable family life; a 60-day minimum advance notice on base changes; an educational program permitting personnel to secure high-school and college degrees in off-duty hours; a wide range of special-service events and facilities; and many others.



Actions taken by the Department of Defense and the Air Staff include the establishment of a "base of choice" program in which the airman who reënlists can, in most cases, be assigned to the base of his own choosing; a fairer and more equitable system of overseas service, with the opportunity whenever possible for the airman's family to travel with him; payment twice instead of once a month; and, in the case of enlisted men and warrant officers, the right to apply for reassignment under certain "hardship" conditions.

Most important of all, Congress has taken action to arrest the manpower deterioration with such measures as a reënlistment bonus, an FHA loan program for men *in service*, and a new salary adjustment which includes more basic pay, flight pay, and miscellaneous allowances.

What, if anything, will these advances mean in terms of reënlistments? SAC surveyed 45,000 airmen—30 per cent of its airmen strength—to find out. On the basis of this survey, SAC estimates that the reënlistment rate will be about 34-35 per cent, as against 23 per cent before the program went into effect. So progress is being made—slowly but surely.

ON the basis of the new reënlistment rate, however, SAC will still need some 88,000 new men by June 1958 to meet its requirement of 174,400. Stated differently, every other SAC airman next year will be inexperienced.

Additional incentives are necessary, therefore, to step up the reënlistment rate. SAC recommends such items as a revised pay structure, better housing and medical care for dependents, a GI Bill for *in-service* schooling (many leave the service to avail themselves of GI Bill educational benefits), restoration of post-exchange benefits (business interests have fought this hard), and more equitable subsistence allowance arrangements for enlisted men.

When the cost of training replacements is considered ($777 million for fiscal 1955 losses), a pay hike that boosts reënlistments *will actually save the taxpayers money*. In his second 4-year term, the skilled technically trained airman costs SAC $20,500 for 92 per cent productive time, as against $22,500 for only 37 per cent productive time during his initial enlistment period.

IN the matter of retaining skilled manpower in the Air Force, the actions of the Soviet Union are in sharp contrast with our own. The incentives for remaining in, or even joining the Soviet Air Force, far surpass ours. The airman in Russia is second only to the top Party official in prestige and reward.

A Soviet Air Force captain with 10 years' service who leads a jet squadron makes $26 more a month than a married captain with similar status in the U.S.A.F. He receives, in addition, free food rations, cigarettes, and uniforms; pays limited income tax; and is given certain discounts in stores and restaurants.

It would be ironic, indeed, if the race for air superiority were lost on the hurdle of manpower.

Guided Missile Progress

A summary of the status of Army, Navy, and Air Force weapons

Name	*Type*	*Sponsor*	*Status*	*Remarks*
		ARMY MISSILES		
NIKE	Surface to Air	Ordnance	Operational	A liquid-fueled, supersonic guided missile which intercepts and destroys enemy targets coming from any direction, regardless of evasive action.
CORPORAL	Surface to Surface	Ordnance	Operational	Equipped with either atomic or conventional-type warhead, it follows a ballistic trajectory to the target. All-weather weapon, propelled by liquid fuel at supersonic speed.
REDSTONE	Surface to Surface	Ordnance	Developmental	Largest successful U. S. ballistic guided missile. Is a future operational field missile. Basic step toward development of Jupiter IRBM.
JUPITER	Surface to Surface	Ordnance	Developmental	Intermediate-range ballistic missile, capable of being launched from land or shipboard, being jointly developed by Army and Navy.
		NAVY MISSILES		
PETREL	Air to Surface	BuORD	Operational	Launched by patrol aircraft, well outside the range of the target's air defense, the missile attacks at high-speed.
SPARROW-I	Air to Air	BuAER	Operational	A solid-propellant supersonic missile used against attacking jet bombers and fighters. Effective against evasive high or low targets.
REGULUS	Surface to Surface	BuAER	Operational	Resembling a swept-wing jet fighter, it was designed for launching from submarines, surface ships, and shore bases. Tactically used against land targets.
TERRIER	Surface to Air	BuORD	Operational	A slim, needle-nosed, supersonic, all-weather weapon designed to intercept aircraft at longer ranges and higher altitudes than conventional antiaircraft.
TALOS	Surface to Air	BuORD	Developmental	A supersonic guided missile for use by Navy aboard ship and by the Continental Air Defense Command on land sites. Larger than Terrier, with longer range possibilities.
TARTAR	Surface to Air	BuORD	Developmental	A solid-propellant rocket to replace 5-inch guns on destroyers and secondary batteries on large ships. More performance than Terrier.
		AIR FORCE MISSILES		
MATADOR	Surface to Surface	USAF	Operational	A subsonic tactical missile, powered by a jet engine, launched from a roadable launcher by a rocket booster. Controlled electronically from the ground, delivers conventional or nuclear weapons several hundred miles.
FALCON	Air to Air	USAF	Operational	An electronically fired and guided solid-propellant rocket. Launched from airplane wing or pod installation miles from the target, it automatically "homes" at supersonic speeds.
SNARK	Surface to Surface	USAF	Developmental	A long-range strategic missile, powered by a turbojet engine. Accuracy and payload capability compare favorably with ballistic missiles.
NAVAHO	Surface to Surface	USAF	Developmental	A rocket-launched, air-breathing, long-range strategic missile with range, accuracy and payload comparable to ballistic missile types.
RASCAL	Air to Surface	USAF	Developmental	A rocket-powered pilotless-bomber-type missile to be carried by strategic bombers, released at long ranges from the target.
BOMARC	Surface to Air	USAF	Developmental	A long-range interceptor-type missile, traveling at supersonic speed; ground-launched, long-range.
ATLAS TITAN	Surface to Surface	USAF	Developmental	Intercontinental ballistic missiles being developed by the Air Force.
THOR	Surface to Surface	USAF	Developmental	Intermediate-range ballistic missile (land-based).

Antimilitary Literature

American books and plays have done much to discredit the military with the civilian populace through false portrayals and overemphasis of isolated abuses — much to the detriment of the national defense

William V. Kennedy

MILITARY men, according to popular concept, aren't supposed to be much interested in literature, and, true enough, most of them are no great authorities on variations of style and philosophy.

Were the services the same islands "sufficient unto themselves" some thought them to be in the 1920's and 1930's, it might matter little whether or not the soldier, the sailor, the Marine, or the airman knew or cared anything about the literature of the day.

That the services are no longer islands in the national life is obvious, and it should be equally obvious that every man interested in the welfare and effectiveness of the services should concern himself with the national literature, for the impact which this literature produces on public opinion and sentiment, and hence on the raw material of service manpower, is enormous.

The novel and the play are the dominating influences in our national literature and it is with these that we are most concerned.

We have among us a group of novelists and playwrights to whom the word "authority," and military authority in particular, is an object of scorn. A number of these men have passed through the services during the past fifteen years.

In more than a few cases they served grudgingly and with contempt for all they saw about them. It was no great surprise, therefore, that when they left the service individuals among the group should produce a succession of books and plays that reflected their bitterness.

Mr. Kennedy is former executive editor of the Pennsylvania Guardsman *and is currently an officer of the 104th Armored Cavalry Regiment, Pennsylvania National Guard.*

It is easy enough to dismiss the more extreme among the antimilitary authors with whatever term of contempt comes to mind. Before you do, however, consider three problems which confront the armed forces today: (1) The lowered prestige of the officer; (2) Distrust of the "military mind"; (3) The extreme difficulty encountered by many youths, particularly among the best educated, in adjusting to military life, and the failure of many to adjust at all.

I do not maintain that these problems were created by the printed page or on the boards of a stage alone. A study of current literature will show, however, that they are, in large measure, an outgrowth of a distorted picture of service life that has been and is still being presented to the public in the American novel and in the play.

For example, there is the oft-repeated theme in the modern novel and play by which the responsible military commander, usually a Regular, is pictured as so morally weak, so stupid, or in one case ("The Caine Mutiny") so close to outright insanity that he must be disposed of by one means or another. The hero, either an enlisted man or a junior officer, then proceeds to set things aright.

Is it any wonder that the civilian filled with such a literary impression has little respect for the armed forces officer and even less for his judgment?

TO deny that the impression has gone so deep is wishful thinking. The novels and the plays that have done most to convey contempt for military leadership have led the best-seller lists and packed the theaters for over ten years.

The military are not the only victims. The Nation, too, has suffered.

The Rev. R. L. Bruckberger, a French author and critic writing in the July 31, 1955, issue of *The New York Times Book Review*, states: "In the last twenty years, the great American novels have become best sellers in France. . . . Alas, what has happened is that those novels have only confirmed the shabby conception that the French already have of America."

A glance at any half dozen current novels and Broadway plays is all that is needed to explain the reason why. A preoccupation with sadism, lust, avarice, insanity, and despair as supposedly the warp and woof of American life has been the hallmark of the American

stage and the American novel for longer than most of us can remember. Within the past few years, homosexuality has joined the sordid list.

Combine the deliberate attack on the prestige of the military with a picture of American society that hardly represents something worth giving one's life for and you gain some insight into the reason for the antagonism which characterizes many young Americans faced with military service.

I DOUBT that there is a single officer or enlisted man in the Regular Army, Navy, Marine Corps, or Air Force who would deny that imperfections and even injustices exist in the services—no matter how proud the individual may be of his service and traditions. The objection registered here is that the exceptions are being portrayed to our own public and to the world, not as exceptions but as the rule.

By the same token, no man who cherishes his own right to read and write what he chooses, guided by the dictates of decency and his conscience, will deny that degeneracy, murder, and cruelty are legitimate subjects of fiction.

But we can object to the presentation of these subjects as the only aspects of our society worth writing about. We can object, also, to their presentation in such a manner that they tend to attract rather than repulse the reader or the playgoer.

Gen. George S. Patton, Jr., once wrote: "It is the cold glitter of the attacker's eye, not the point of the questing bayonet that breaks the line. It is the fierce determination of the driver to close with the enemy, not the mechanical perfection of the tank that conquers the trench. . . ."

The "cold glitter" of which Patton spoke is made up no more of cynicism and despair—the end products of our modern novelists—than it is of peaches and cream.

FILL a young mind with the modern American novel and play and you must expect what you get—sullenness, moral indecision, and a marked resistance to authority in any form. "As a man thinketh, so he is."

Every man who wears the uniform is honor-bound to fight the tide of rotten literature that pours day in and day out from the printing presses and from the stages of our most respected theaters.

Negation alone, however, will never win a literary battle any more than the defensive can, by itself, win a decision in war.

Fortunately, there has emerged in the last few years the start of a newer and healthier American literature. It consists of the biographies, autobiographies, and after-action reports that have grown out of World War II and Korea and of the historical material produced as a result of the current reexamination of American history, particularly of the Civil War era.

Douglas Southall Freeman, Bruce Catton, S. L. A. Marshall, Hanson W. Baldwin, and Ernie Pyle have produced or are still producing some of the most potent nonfiction ever written. If the elements of great literature are truth, clarity, emotional power, and a fascination for every people and every age, then these men are producing what may come to be recognized as the truly great literature of our times.

The smut, sadism, despair, and psychiatric nonsense of some playwrights would indicate that in an age of greatness they were content to sate themselves with its slops.

If great fiction is ever to come of the events of our age it will come many years hence, just as Stephen Crane's "The Red Badge of Courage" and Tolstoy's "War and Peace" followed their subject matter by a generation or more.

If great fiction does come of this age it will be based, not on the ravings of current fiction, but on the vivid journalism of the S. L. A. Marshalls, the Ernie Pyles, and the Hanson Baldwins. These are the men who, in an age of greatness, kept their heads and recorded in clear, honest, and forthright words the heroism that will make it an age to be remembered.

If the great nonfiction now emerging is to have its full effect it must be read by those most capable of appreciating it. It must be used to counteract the insidious propaganda of the principal fiction writers, and it must be placed in the hands of our youth.

SAD to say, this literature is not reaching the military audience that it must if it is to produce the impact desired. In hundreds of hours of travel in aircraft and by train in company with officers of all ranks and services, I have seen only one, an Air Force major with a volume of D. S. Freeman's "Lee's Lieutenants," reading a book that could be of any value to him as a fighting man and as a human being.

If senior officers in every service were to demand among their subordinates even a minimum knowledge of the best in current biography, journalism, and history the present grave deficiency could be corrected. The commander can suggest titles in formal talks to his officers, during an interview with an incoming officer, or in informal discussions.

This presumes, of course, that the commander himself is willing to take the time and trouble to keep up with the literature of the day.

However, if he considers that, as a man of action, such is unworthy of his consideration, then he had best remain silent when he finds himself held up before his fellow countrymen as incompetent.

Of even greater importance is the guidance which the military officer can give to youth. Starting with his own children and continuing with all who look to him for instruction he can encourage the reading of sound literature, both fiction and nonfiction.

The primary method of communication among the various portions of our society is the national literature. It is most important that the officer have a clear knowledge at all times of the trends apparent in this literature, the help that it may provide him in furthering his work, or the threat that it may pose to him as a leader of men and a responsible member of the community.

This help and threat are apparent today in our national literature. Every officer who values his own prestige and the prestige of the service must learn to use the one and fight the other.

Defense Highlights: Monthly Review and Outlook

• Congratulations are in order for the Ordnance Corps of the Army and the distinguished Chief of Ordnance, who now wears a third star. Lieut. Gen. Emerson L. Cummings was nominated for this honor by the President and confirmed by the Senate on July 20, 1956.

The advanced rank was held only once before in the 144 years of Army Ordnance when Lieut. Gen. Levin H. Campbell, Jr., World War II Chief of Ordnance, was so honored. Indicative of the vast responsibilities of the Ordnance Corps are the statistics that it now boasts one lieutenant general, nine major generals, and twelve brigadier generals.

All members of the A.O.A.—38,000 strong—wish Lieutenant General Cummings and his colleagues continued success.

• Navy's first atomic-powered submarine, NAUTILUS, has cruised 50,000 miles without refueling in 18 months of operations and with much less maintenance and repair trouble than anticipated. This successful record has advanced nuclear marine engine programs several years ahead of predicted schedules.

• The Navy says it has succeeded in sending low-flying bombers 1,000 miles into the heartland of America without being detected by radar. Defense forces were alerted that the attempt would be made. Wiseacres believe the Navy should coördinate its activities with our defense forces "on a high level." Seriously, science has yet to solve satisfactorily the detection of low-flying aircraft. A larger ground observer corps is badly needed.

• Stanford Research Institute in 1954 began to develop means for disseminating prompt and specific information on damage in case of an attack on our country. The Institute is correlating information on areas of damage, casualties, and effects on facilities and resources. It is emphasizing mechanized means of fallout analysis and compilation of data required. Other research objectives include provision for an attack surveillance system to communicate information on location of ground zero, weapon size, and height of burst to a computer center. Such information is vital to those who would have to direct rehabilitation of stricken areas.

• While seventy-six North American cities were wiped out again by another make-believe enemy attack called Operation Alert, selected Government activities operated from their "secret" centers. In general, communications and control were better than last year. Nevertheless a plan is in the wind to ask all citizens to take forty to sixty hours of Civil Defense training to prepare now for a national emergency.

• Present military policy calls for putting our troops into operational areas—and then denying them mobility. As Lieut. Gen. J. M. Gavin expressed it, we are "putting a policeman on a street corner but tying him to a fireplug." Army can airlift only the combat echelon of one division, with a minimum of technical service troops and no accompanying supplies. No plans have been worked out yet to airlift a division force or 11,000 tons. Senator Stuart Symington commented that it seemed "we are carefully planning to stay behind." To complicate the issue, Strategic and Tactical Air Commands also require airlift—presently inadequate.

• The armed forces have earmarked more than $12 billion of the total 35 billion defense appropriation for major procurement and production during the months ahead. Of the new funds, 70 per cent will go into the procurement of aircraft and guided missiles, 13 per cent into shipbuilding, and about 10 per cent into electronics. The remaining seven per cent will go for combat vehicles, ammunition, and production equipment and facilities. Thus ordnance and armament acquire new glamour with less conventional material and more guided missiles, aircraft rockets, and surface-to-surface rockets.

• Here's a secret. Navy has a weapon that "will revolutionize antisubmarine warfare." Secretary of the Navy Thomas said so. The statement is particularly significant because Russian sea power is concentrated in submarines. Mr. Thomas did not elaborate on the nature of the new development, only adding that Navy had such a weapon "on hand." Speculation is that some form of underwater atomic antisubmarine weapon has been developed. In addition, the Navy's Secretary hinted that great improvements have been made in both radar and sonar used in surface and underwater detection of submarines.

• The Army also has a secret. In recent secret Army testimony before a congressional committee, now made public, Army generals startled Senators by reporting they believe they have the answer to the intercontinental ballistic missile with a hydrogen warhead. They predicted an "antimissile missile," capable of knocking down hostile ICBM's, will be feasible in four or five years.

• The Air Force, Navy, and the Atomic Energy Commission are planning to establish a joint weapons testing range near Albuquerque, N. Mex. The increased versatility of nu-

clear weapons has imposed testing requirements which make it desirable to have a joint range for acquisition of ballistic data and study of new bomb shapes. A 100-mile range is now needed to deliver new bombs to an impact area that can be instrumented, such as the jointly operated range at White Sands, N. Mex.

• There were few military surprises at the annual observance of Soviet Air Force Day. The big air show was held in Moscow in June and attended by delegations from twenty-eight countries. The air-power demonstration featured fighters rather than bombers, defense rather than offense. On display were only 16 medium and heavy bombers in comparison with more than 130 fighters, several of them new types. The greatest interest was centered in the 4-jet Bison bomber —the Russian's latest—about which there is much guessing as to the numbers in operation.

• Gen. Nathan F. Twining, Air Force Chief of Staff, told the Senate Armed Services Committee that the Moscow air show was interesting, not only for what it showed but equally for what it failed to show. Completely missing from the array of exhibits were any guided missiles, even of the most elementary kind. There is, of course, ample evidence that the Russians have such missiles. But throughout General Twining's stay in the U.S.S.R., his Russian hosts maintained a veil of secrecy around their activities in this field of weapons. Nevertheless the general was convinced that the U.S.S.R. "while certainly not abreast of us today can and is progressively narrowing the technological lead of the West."

• During the past eleven years Britain has been giving away, selling, or lending warships to Commonwealth navies. Faced with defense budget cuts at home, the future of the active fleet, already overextended around the world, is causing Royal Navy officials the greatest anxiety. Bases on Ceylon may be lost, and the Chinese population in Singapore is politically restive. The growing strength and efficiency of several Commonwealth navies has led London experts to believe that these fleets can and should now assume some of the responsibilities for the naval protection of strategic sea areas and bases of mutual Commonwealth importance.

• The Navy's experimental vertical-lift craft aptly designated the Sea Bat, will be able to hang in the air, dart in any direction, hover close to the surface of the sea and return to its base under electronic control from shipboard or land. The unmanned and completely automatic machine will perform numerous missions that existing aircraft or helicopters cannot do. The craft is expected to be particularly useful on hazardous missions where there is an extremely high risk of losing the pilot. The small size and compactness of the Bat will enable it to be stored in submarines and operated from the confined spaces of small ships.

• The Defense Production Act has been extended for two years. Congress also cleared a bill to continue the Government's power to curb exports of some goods on our strategic stockpile list for the same period. A new survey will be made of the iron and steel scrap situation. A House provision to require detailed financial statements from businessmen in the "executive reserve" program who fill Federal jobs in an emergency was killed in conference. Democrats and Republicans from industrial areas unsuccessfully opposed a section giving congressional "encouragement" to the dispersal of defense industry to nontarget areas throughout the Nation.

• The first issue of Logistics, a quarterly report of the American Ordnance Association, was mailed in July to all company members, and officers of the Association. This latest issue of Logistics is a special report on "Guided Missile Manufacture—A plan for Improving Production," by Col. Charles W. Eifler, Ordnance Corps, U. S. Army. Colonel Eifler, now on duty overseas, was previously director of the Guided Missile Section, Research and Development Division, Office of the Chief of Ordnance.

The author presents a well thought-out plan for the close scheduling of weapon system development. He advocates carefully planned overlapping of development, prototype production, testing, and operational use to decrease the discouraging time lags encountered in the past from drawing board to effective combat weapon. The excellent diagrams greatly assist in clarifying his well-founded recommendations.

Copies of Logistics are available to individual members of the Association without cost upon request to the editorial offices of the A.O.A.

• Defense Mobilizer Arthur Flemming assures us that his agency does not plan to change its dispersal policies as a result of an amendment Congress added to the Defense Production Act. The amendment instructs Government agencies to encourage dispersal in the construction of plants for defense production, by granting permits for fast amortization for tax purposes and other means. Dr. Flemming regards

Here is the new conference schedule of the Industrial College of the Armed Forces. Each session covers eleven days with starting dates as follows:

	1956
Birmingham, Ala.	*Sept. 17*
Denver, Colo.	*Sept. 24*
Tucson, Ariz.	*Oct. 22*
Butte, Mont.	*Oct. 22*
Hartford, Conn.	*Nov. 26*
Augusta, Ga.	*Nov. 26*
	1957
Ventura, Calif.	*Jan. 21*
Beaumont, Tex.	*Jan. 21*
Jacksonville, Fla.	*Feb. 18*
Roanoke, Va.	*Feb. 18*
San Antonio, Tex.	*Mar. 18*
Akron, Ohio	*Mar. 18*
Hutchinson, Kans.	*Apr. 15*
Providence, R. I.	*Apr. 15*
New York, N. Y.	*May 6*
San Diego, Calif.	*May 13*

this amendment as providing congressional backing for the dispersal policy he issued on January 11, 1956. His policy lists several criteria other than dispersal which should be considered in granting Government assistance for industrial expansion.

• Canada is planning no sharp departure from her present defense policy or budget. This year, as last, the Royal Canadian Air Force will get the lion's share of the defense appropriation of $1,775,000,000. Of every dollar spent on defense, the air force gets 42 cents; the army, 24.7 cents; the navy, 17.6 cents; mutual aid to Atlantic Pact allies, 7.7 cents; defense research, 4.3 cents; and other miscellaneous costs, 3.7. The manpower level of Canada's armed forces will be held at the present figure of 116,715 uniformed personnel. Canada will build an American-type air-to-air missile and is developing a supersonic 1,400-mile-an-hour all-weather jet interceptor airplane—the C-F-105.

• Maj. Gen. E. J. Timberlake, commander of the Ninth Air Force, recently emphasized the importance of the development of the human element in our military forces fully as much as material elements in these forces. We are confident that all humans will be immensely pleased by the general's additional statement: "In this human element lies an extraordinary opportunity to increase our power and reduce our costs; it offers the quickest and highest return for money invested in national security. Our ingenuity in the use of man has not kept pace with our ingenuity in the use of the machines man manufactures."

• As the first step in the concentration of our forces overseas, the Defense Department will abolish the Far East Command with headquarters in Tokyo. Jurisdiction will be transferred to the Navy under the direct command of Adm. F. B. Stump, Commander in Chief, Pacific Fleet. Headquarters of the United Nations Command will remain as a separate naval command and will reëstablish its headquarters in South Korea. This command will be under Army control but receive logistic support from the Navy. Similar but less far reaching changes were planned in the European, Caribbean, and Alaskan Theaters. This entire reorganization is purportedly being undertaken to provide greater economy of forces and more flexible command arrangements and to reduce some of the divided responsibilities.

• Army aviation wants more money. Last fiscal year about $13 million was allocated for Army research and development, although $18 million was sought. This year Army wanted $27 million for its research—received only $12 million. Army now wants an allocation of an additional $14,800,000 to carry forward an aggressive program of aviation development. In an impressive plea to the Congressional Subcommittee on Airpower, Lieut. Gen. J. M. Gavin, Chief of Army Research and Development, and Maj. Gen. H. H. Howze, Director of Army Aviation, described the following needs: larger fixed-wing cargo carriers, faster observation aircraft that can also fly slowly, rugged helicopter and lightplane design to reduce maintenance and replacement in the field. The Army was frustrated by lack of airborne "eyes" in Korea and is now faced with inadequate mobility in the combat zone in a widely dispersed atomic battle.

• When the United States entered World War I, the National Guard sent into active Federal service 12,000 officers and 368,000 enlisted men. As we drifted into World War II during 1940-1941, 20,676 Guard officers and 279,358 enlisted men went into active service. During the Korean emergency, the Army National Guard furnished eight infantry divisions, two regimental combat teams, and several thousand special units of all branches of service. The Air National Guard furnished sixty-six tactical squadrons and nearly eighty per cent of its personnel. Today the total strength of the Army and Air National Guard is 471,532. Units are located in more than 2,500 communities in the United States and the territories. The Guard is a great national asset. Let's keep it strong and help it to grow stronger.

• President Eisenhower vetoed a defense bill because Congress exceeded its powers. The President discovered that a $2 billion military construction measure would restrict Pentagon ordnancemen in developing the Air Force's Talos guided missile. He objected to one section because it would require Defense Secretary Wilson to "come into agreement" with the armed services committees of Congress regarding the missile. This restriction, Mr. Eisenhower said, violates "the fundamental constitutional principle of separation of powers." The Senate and the House quickly prepared a new bill that eliminated the objectionable features.

• Secretary of State Dulles left it up to the military experts in July to decide whether there should be an all-around reduction in American ground forces. There appears to be a worldwide trend in the direction of less emphasis on manpower and more weight on modern weapons, the delivery of such weapons, and protection against such weapons. Maybe, as Mr. Dulles suggests, the next decade will see political developments that will "make it practicable and safe to rely less upon military force and make it possible to effect some reductions in our overseas disposition of forces." We sincerely hope that lessening international tensions can be taken on their face value and not viewed as the smile before the crushing surprise blow is delivered.

• Gen. Nathan F. Twining expressed the view that the Air Force could effectively spend the extra $900,000,000 Congress voted to it over the Administration's objections. The Air Force Chief of Staff was not specific about how the extra funds would be expended but noted that not all the money would be used for a speed-up of B-52 production. He explained the need for more high-speed refueling tankers and stressed using about $100 million for research and development.

The Manpower-Firepower Enigma

An Editorial

A STORM is brewing in the Nation's Capital over reducing the armed forces' manpower. It is important to have a look at the real nature of the problem before the issue becomes confused with the smoke of political battle.

Firepower, whether the target is strategic or tactical, has increased not only in devastating nuclear weapons but also in conventional weapons since World War II. Machine guns—both airborne and for troops—fire faster and at greater velocities while artillery, antiaircraft, and aircraft missiles all have been improved greatly both in hitting power and accuracy of control.

Thus, for the same number of men we might count on a thousandfold more firepower if there were an atomic war and roughly four times more power in case of a war with conventional weapons.

So before the enigma of balancing manpower and firepower can be explored, the difficult question must be decided as to what type of weapons would be used in case of another war. What proportion of nuclear and high-explosive weapons should be planned and how much reliance should be placed on the "new" weapons?

High officials of the Department of Defense partly excuse their perplexity in deciding on adequate forces by pointing to the startling changes that may be possible in warfare with missiles and rockets that are being developed. This facet of the question seems to require clarification and common-sense examination.

The clarification needed was expressed before a congressional committee by Rear Adm. J. E. Clark: "It must be appreciated that medium- and long-range missiles to be economically acceptable must carry nuclear warheads." Thus, advanced weapon development is leading primarily into more means of launching nuclear destruction.

Common sense dictates that we should count the weapons now in our arsenal and ensure that we are ready to use them to their maximum capability. Manpower should not be cut because we hope newer but not fully developed weapons will give greater useful firepower.

THE core of the enigma is whether atomic weapons will be used in any future war, large or small. Hydrogen-bomb warfare seems too horribly unprofitable for any nation to launch, provided the United States remains alert and maintains its present retaliatory strength.

However, all the nations of the world seem to be reorienting their armaments for atomic warfare. They are leaning either on their own supply or support from this country and are reducing their manpower. The reasoning seems to be that we all will rely on tactical atomic weapons. This in itself is a shaky platform if our armed forces are weakened greatly and we are faced with a so-called "police action," as in Korea, with an inadequate army but afraid to use atomic weapons.

From the foregoing it would appear the United States must maintain a large body of armed men or let it be known that we will fight all wars with tactical atomic weapons. Only on this basis could we talk sensibly about reducing forces because of increased firepower, since our far-flung overseas commitments have more than offset the increased firepower of postwar conventional weapons.

Should we reduce our overseas commitments it seems essential to maintain larger forces at home ready to spring back. They must be trained and ready for years to come, as none of our allies are actually building up enough military power to hold the line again while we prepare—and preparing from a position of unpreparedness compounds the waste of war.

SO far it has been considered only that increased firepower might permit decreased manpower. There is also the aspect that as firepower becomes more destructive, more rather than less manpower may be needed to replace heavy losses or take prompt advantage of a break-through. A future war between two determined antagonists would not necessarily be a quick one unless a maniac resorted to hydrogen weapons with the probability of mutual annihilation. Thus, manpower, alert and ready on the perimeter of the sphere of action, might be the decisive factor.

Proponents of manpower reductions claim that the tremendous cost of new weapons must be balanced by reducing manpower. Undoubtedly there is a sensible area where manpower and firepower costs intersect, but sole concern over cost to the detriment of manpower would make America and the free world easy prey for an aggressor.

In this discussion of firepower versus manpower there is no plea to maintain the status quo or any set percentage for land, sea, and air forces. In fact, some reduction based on increased percentage of experienced professional men in the armed services, is sensible.

It is evident that a searching examination of the rock-bottom needs of national preparedness for military action is in order before manpower reductions are recommended with careless abandon. Not only should we be extremely cautious when the Communists smile, but we must not be led astray into the wonderland of untried arms or fantastic weapons on the drawing board.

It seems equally unwise to maneuver the country into a position of having to fight with atomic weapons in all circumstances. Increased firepower undoubtedly decreases the need for additional manpower, but it is a relative situation among the stronger nations. We suspect that our military manpower may already be at a low ebb.

New British Aircraft

The British De Havilland Venom N.F.3, above, is primarily a defensive night fighter but may be employed as a day fighter in foul weather. The Gloster Javelin all-weather night fighters, below, are powered by twin Armstrong-Siddley turbojets and are equipped with long-range radar and four Aden 30-mm. cannon that can be aimed electronically (British photos).

ASSOCIATION AFFAIRS

Philadelphia Post Awards Medal to General LeMay at Annual Meeting

The Philadelphia Post assembled for its annual meeting at the New Castle Air Force Base, Del., on Wednesday May 23rd. Over 300 members journeyed from the city to witness demonstrations and tests of air power and to pay honor to Gen. Curtis E. LeMay and his Strategic Air Command.

During the afternoon, pilots of the National Guard air squadrons of New Castle County exhibited their skill in F-84 fighter interceptors and F-94 all-weather interceptors amidst the roaring of high-powered jet engines.

The annual meeting was called to order in a large hangar by Post President William H. Worrilow, Sr., who first called on Albert W. Gilmer, chairman of the nominating committee, to present the new slate of officers and directors. The nominees, headed by Everett B. Webster as president, were unanimously elected. The new officers and directors who are among the distinguished industrialists of Delaware, Eastern Pennsylvania, and Southern New Jersey appear in the Annual Directory which accompanied the July issue of ORDNANCE.

In special tribute to General LeMay, he was presented with the Philadelphia Post's John C. Jones Gold Medal for outstanding service to the Nation. Mr. Gilmer made the presentation and read the accompanying citation:

"The Nation is heavily indebted to General LeMay for his singleness of purpose, devotion to duty, and dedication to his country in making the Strategic Air Command the most powerful defender of peace in the world."

In accepting the Jones Medal, General LeMay gave full credit for this honor to the personnel of the Strategic Air Command.

In his address the general described the structure and mission of his command. He explained the close teamwork required of his crews and his need for more dedicated young men to staff the Nation's deterrent of aggressors.

In concluding the meeting Mr. Worrilow turned over the president's silver-trimmed gavel to Mr. Webster, his successor. The new president then presented a sterling silver tray to the retiring Post president inscribed with the names of the officers and directors who served under Mr. Worrilow during his highly successful two years as Post president.

The air demonstrations and annual meeting were followed by a reception and dinner at the near-by officers' club. During the dinner Mr. Webster and Arthur J. Seiler spoke briefly to thank the Crown Cork & Seal Company for its sponsorship of this outstanding meeting and to express the appreciation of all the members for the hospitality and excellent arrangements provided by the New Castle Air Force Base and the thrilling air performance of the pilots who took part in the demonstrations.

• **AT BINGHAMTON, N. Y.**—The Tri-Cities Chapter of the Empire Post met on Thursday, May 10th at the Carlton Hotel to honor Vice Adm. Willard A. Kitts of General Electric's Industrial Atomic Products Division who was introduced by John H. Bouman, Chapter chairman.

Over sixty members and guests were on hand to welcome the guest of honor and to meet Col. William A. Davis who journeyed down from Rochester where he has recently taken charge as deputy chief of the Ordnance District.

Admiral Kitts spoke on "Peaceful Applications of the Atom" illustrating his remarks with the film, "A for Atom."

• **AT LOS ANGELES.**—Secretary of the Army Wilber M. Brucker was guest speaker at a luncheon sponsored by the Los Angeles Post and other patriotic organizations of the area on May 17 to commemorate Armed Forces Week. A.O.A. members comprised a large part of the audience at this affair, held at the Biltmore Hotel.

Lieut. Gen. Robert N. Young, commanding general, Sixth Army, and Hon. Norris Poulson, Mayor of Los Angeles, made brief remarks prior to Secretary Brucker's address.

The Secretary stressed the need for all citizens to stand firm in their belief in our way of life. He noted that the determination of our citizens and the strength of our armed forces were the principal deterrents to Communist aggression. He then described the rôle of the Army and the new weapons that give it great power as well as mobility and flexibility.

Dr. Kent Receives Highest Civilian Service Award

Dr. Robert H. Kent, one of the Nation's leading ballisticians, who has been employed at Aberdeen Proving Ground since 1922, was presented the Exceptional Civil Service Declaration, highest civilian award bestowed by the Army, by Lieut. Gen. E. L. Cummings, Chief of Ordnance, and Maj. Gen. Carroll H. Deitrick, commanding general of the Proving Ground. A gold medal accompanied the award, presented at a retirement dinner for Dr. Kent given at the Main Officers' Club at Aberdeen on Tuesday, July 31st, by the staff of the Ballistic Research Laboratories. Dr. Kent was associate technical director of the Laboratories until his retirement on July 31st.

At other ceremonies held at the Labora-

CROZIER HOUSE

The program to convert Crozier House to A.O.A. headquarters is proceeding very slowly. At this writing the principal problem is to obtain clarification from the District of Columbia Commissioners regarding the zoning rules that are applicable in the area where the house is located.

As noted earlier, the waiting period required by District estate laws will end in October when the Association will obtain complete title to the property from the executors.

tories on Tuesday morning, establishment of an R. H. Kent award was announced for the first time.

The new Kent Award will be given each year to the person at the Laboratories "whose work is most worthy of recognition." The award will be given first on Dr. Kent's birthday, July 1, 1957, and will be presented annually as near to his birthday as possible. Whenever practicable, Dr. Kent is expected to make the presentations to the award winners.

Dr. von Braun Speaks on Missiles at Frankford Arsenal's Ordnance Day

The auditorium of the Frankford Arsenal, Philadelphia, Pa., was filled to capacity by members of the Philadelphia Post of the Association to hear Dr. Wernher von Braun, noted guided-missile expert.

The occasion was the observance of the 140th anniversary of the arsenal on American Ordnance Association Day, May 22, 1956. The entire week had been proclaimed Frankford Arsenal Week by the mayor of the city. Brig. Gen. Joseph M. Colby, commanding general of Frankford, was host. The presiding officer was W. H. Worrilow, president of the Philadelphia Post and president of Lebanon Steel Foundries, Lebanon, Pa.

Dr. Wernher von Braun

Dr. von Braun delivered a stirring address including a message from Maj. Gen. J. B. Medaris, commanding general, Army Ballistic Missile Agency, Huntsville, Ala.

The program began at 11:30 a.m. when members and guests were given an opportunity to review ordnance exhibits which had been arranged for the occasion. Following the luncheon they were taken on tours of the fire-control instrument section, fire-control manufacturing operations, small-arms and artillery ammunition manufacturing activities, and the Pitman-Dunn Laboratories.

The invocation and benediction at the luncheon were given by the Rev. James Quinn, rector, Church of the Assumption, Philadelphia. In addition to the main discussion by Dr. von Braun, addresses were given by General Colby, Mr. Worrilow, and Col. Leo A. Codd, executive vice-president of the Association, Washington, D. C.

Seated at the speakers' table in addition to those already named were: James E. Burke, chairman, A.O.A. Fuze Committee; G. W. Cain, executive assistant, Frankford Arsenal; Dr. Henry Allen, director of Franklin Institute; Col. W. F. Rockwell, director, A.O.A. Pittsburgh Post; W. N. Howley, chairman, A.O.A. Shell Committee; Col. W. L. Clay, former commanding officer, Frankford Arsenal; Maj. Gen. R. L. Maxwell, former president, New York Post; Brig. Gen. Jean Engler, Assistant Chief of Ordnance, Industrial Division.

Also at the head table were: Brig. Gen. W. R. Slaughter; Brig. Gen. T. C. Rives, secretary, A.O.A. Electronics Division; A. J. Langhammer, chairman, A.O.A. Powder Metallurgy Committee; Col. Pat Stevens, III, commanding officer, 24th AAA Group; Ralph Goetzenberger, chairman, A.O.A. Fire Control Instrument Division; T. C. Kempin, civilian executive assistant, Frankford Arsenal; and Lieut. Col. P. B. Reed, Jr., executive officer, Frankford Arsenal.

F. B. Reybold Elected Washington Post President

The Washington Post held its final meeting of the season at the Army-Navy Country Club on Thursday, May 17th. The Washington members turned out in good numbers to pay honor to George M. Riveire, vice-president, Goodyear Tire & Rubber Company, who presided at his final meeting as Post president. Mr. Riveire has led the Post through two of its most successful years in which his genial direction of meetings and the high caliber of the guest speakers encouraged a large turnout of loyal members. In addition, the enthusiasm engendered by Mr. Riveire has helped to boost Post membership by over twenty per cent.

The guest speaker at this occasion was Clark C. Vogel, Deputy Director, Division of International Affairs, Atomic Energy Commission. Mr. Vogel outlined the aims of the AEC in formulating the Administration's plans for international coöperation in atomic energy. Among the twenty-seven nations which have agreed to participation in the program three already have contracted with United States industry and eight others are in process of so doing.

Prior to the address the slate presented by R. P. Williams, chairman of the Post nominating committee, was unanimously accepted. Franklin B. Reybold of Alco Products, Inc., former Post vice-president, will succeed Mr. Riveire. The other officers are shown in the new directory which accompanied the July issue of ORDNANCE.

Mr. Riveire expressed the appreciation and heartfelt thanks of all the members for the outstanding work done by the Post chairmen who had done so much to maintain a fast pace in Post activities; namely, Col. M. B. Harris, Arrangements Committee; John Tope, Programs Committee; and R. W. Berry, Membership Committee. Special thanks were given to Stewart L. Magee who was reëlected as Post secretary-treasurer.

College R.O.T.C. Units Award A.O.A. Scholarship Keys to Outstanding Ordnance Cadets

Each year the honor Ordnance cadets in the R.O.T.C. units in colleges throughout the country are awarded the American Ordnance Association Scholarship Key and a year's membership in the Association. These awards recently were made at institutions mentioned below. Other awards were announced in the July-August issue of ORDNANCE.

University of Arkansas.—Cadet Henry L. Bauni, Jr., Newport, Ark., was awarded the American Ordnance Association gold Scholarship Key in June by Dr. John Tyler Caldwell, president of the University.

R. L. Tapp J. P. Gullen

W. H. Smith R. E. Bedford

University of Cincinnati.—Cadet Robert G. Thesing, Lancaster, Ohio, graduated in June 1956 and majored in mechanical engineering.

The Citadel.—Cadet Lieut. Col. Richard L. Tapp, Columbia, S. C., won the Association's award as the outstanding cadet at the Ordnance R.O.T.C. summer camp at Aberdeen Proving Ground, Md., in August 1955. He was one of twenty-eight Citadel seniors listed in Who's Who in American Colleges and Universities.

University of Connecticut.—Cadet Lieut. Col. John P. Gullen, Hartford, Conn., majored in industrial administration and received his bachelor of science degree on June 10, 1956. He was selected as a distinguished military graduate and will be commissioned a Regular Army second lieutenant in the Ordnance Corps.

Dartmouth College.—Cadet Lieut. Col. Wesley H. Smith, Upper Montclair, N. J., was an economics major and received his A.B. degree in June 1956. He was enrolled in the Army R.O.T.C. program and was a distinguished military graduate.

North Carolina State College.—Cadet Maj. Robert Edwin Bedford, Goldsboro, N. C., is majoring in nuclear engineering and is a member of the American Institute of Physics and Scabbard and Blade.

Oklahoma A. & M. College.—Cadet Lieut. Col. Joseph W. Tripp was presented with the American Ordnance Association scholarship award on May 8, 1956, by Maj. Gen. William S. Key. He received a bachelor of science degree in agronomy.

Purdue University.—Cadet Dean O. Cliver, Berwyn, Ill., is an agriculture major (dairy production) and is vice-president of Purdue Ordnance Association.

Seattle University.—Cadet Col. Thomas M. Budinich, Jr., Seattle, Wash., was a member of National Society of Scabbard and Blade and upon graduation was commissioned into the Regular Army.

Stanford University.—Cadet Myron P. Hollister, Stanford, Calif., has accepted a Regular Army commission in the Ordnance Corps of the Army.

Virginia Polytechnic Institute.—Cadet 2nd Lieut. Charles A. Ross, Richmond, Va., majored in mechanical engineering. He is a member of the Society of American Military Engineers and the American Society of Mechanical Engineers and has applied for a Regular Army commission.

T. M. Budinich, Jr. C. A. Ross

San Francisco Post Hears General Palmer Cite Need for Airborne Army

On May 17th Gen. Williston B. Palmer, Army Vice Chief of Staff, told the spring meeting of the San Francisco Post that today's Army no longer can be earthbound.

"The Army's job is to fight on land," he said, "but this does not mean we are earthbound . . . We want to be able to move divisions by air to any distant small war. We have no desire to run a fleet of strategic air transports . . . I don't care who carries us, but we want to ride in airplanes!"

The man who directs the day-to-day routine of the Army spoke with considerable frankness to 475 Ordnance Association members present because of what they stood for, he said, in the national defense. He was introduced by Brig. Gen. J. A. Holly, U.S.A. (Ret.), a former colleague and now special assistant to Post President James M. Hait, vice-president of Food Machinery and Chemical Corporation.

"On the battlefield," General Palmer said, "we need airplanes and helicopters for observation, for command, for shifting troops, for front-line supply, for moving our wounded. These air vehicles—and I wish to emphasize air vehicles—we do operate ourselves."

Other honor guests at the speakers' table were: Col. Calvin A. Heath, commanding the San Francisco Ordnance District; Norman R. Sutherland, Post director and president of the Pacific Gas & Electric Company; G. M. Greenwood, delegate at large to the A.O.A. Council and vice-president of Rheem Manufacturing Company; Brig. Gen. Jean E. Engler, Assistant Chief of Ordnance; Dean Witter, regional A.O.A. vice-president; Brig. Gen. Louis J. Rumaggi, chief of staff, Sixth Army; Vice Adm. F. S. Low, Commander, Western Sea Frontier; E. R. Peterson, Post vice-president and vice-president of Standard Oil Company of California; Maj. Gen. James W. Spry, commander, Parks Air Force Base; and William E. Butts, Post vice-president and president of General Metals Corporation, San Francisco, Calif.

Present at the San Francisco Post meeting were, seated left to right: E. R. Peterson; Gen. Williston B. Palmer, Army Vice Chief of Staff, guest of honor; James M. Hait, Post president; William E. Butts. Standing, left to right: Jack L. Ashby, Fred B. Whitman, Dean Witter, Lieut. Gen. LeRoy Lutes, N. R. Sutherland, G. M. Greenwood, and Col. Calvin A. Heath, secretary-treasurer of the Post.

Secretary Higgins and Procurement Panel Address West Coast Businessmen

In a whirlwind tour in June the Assistant Secretary of the Army for Logistics, the Hon. Frank H. Higgins, traveled west with a panel of six distinguished officers to present the procurement policy of the Army at meetings in the principal cities of the Pacific Coast. A member of the A.O.A. staff had the pleasure of accompanying this cavalcade and participating in these meetings. The A.O.A. was well represented at each affair and was a cosponsor at some of them.

The panel was comprised of Maj. Gen. Henry R. Westphalinger, director of procurement, Office of the Deputy Chief of Staff for Logistics; Brig. Gen. Jean E. Engler, chief of the Industrial Division, Office of the Chief of Ordnance; Col. William H. Gurnee, Jr., chief of the Procurement Branch, Office of the Assistant Secretary of the Army (Logistics); Lieut. Col. William E. Campbell, Jr., military assistant to Secretary Higgins; Col. Nicholas R. Voorhis, chief of Procurement Law Division, Office of the Judge Advocate General; Jack W. Askins, Small Business Adviser to the Assistant Secretary of the Army (Logistics) and to the Deputy Chief of Staff for Logistics.

The first port of call was Ogden, Utah, after the Secretary had stopped briefly in Kansas City to inspect several new Ordnance facilities in that general area. The citizens of Ogden and Salt Lake City gave the party a royal welcome and turned out in large numbers to participate in the panel discussions.

Mr. Higgins also took time out to present an award to the Ogden General Supply Depot for meritorious participation in E bond purchases.

The next day after a flight over the beautiful scenery of the Northern Rockies, the party landed at McCord Air Force Base where the Secretary and selected officers flew over to inspect Fort Lewis and Mr. Rainier Ordnance Depot. The meeting at Seattle was sponsored by a joint committee from the five Army technical associations in the area; namely, the Armed Forces Chemical Association, Armed Forces Communications and Electronics Association, American Ordnance Association, the Society of American Military Engineers, National Defense Transportation Association, and the Quartermaster Association.

Representatives of all the important industries of the Northwest were on hand at the afternoon panel discussion and the evening dinner meeting at the Rainier Club. In the Seattle area, special praises were accorded P. L. Danforth of the Quartermaster Association, chairman; Col. Fairman B. Lee of the A.O.A.; Fred D. Purdom, N.D.T.A.; and Hanford Thayer, Military Engineers, for the excellent program arrangements.

Col. Marmion Mills, president of the local A.O.A. Post, was chairman of the panel discussion meeting, and Col. R. Kearns, president of the local Quartermaster Association Chapter presided at the evening affair. On behalf of industry, Paul Pigott, president of Pacific Car and Foundry Company and a regional vice-president of the A.O.A., thanked Secretary Higgins for his informative presentation and pledged the full coöperation of the facilities of the Northwest to meet the Army's needs.

Next stop on the journey was San Francisco on Monday, June 18th. In the Bay City the prime mover of the meeting was the American Ordnance Association ably backed by the four other technical associations.

Assistant Army Secretary Frank H. Higgins, left, addresses procurement conference in San Francisco. Others, left to right, are: A. B. Layton, toastmaster; Stanley Hiller, Hiller Helicopters; L. S. Fletcher, A.O.A. Council member; Brig. Gen. J. E. Engler, Assistant Chief of Army Ordnance; and J. M. Hait, Post president.

The center of activity here was the Hotel Fairmont where A. B. Layton, vice-president and director, Crown Zellerbach Corporation, and a former president of the San Francisco Post, presided at the panel discussion and the dinner meeting in the Gold Room.

After Secretary Higgins' excellent talk following the dinner meeting, Stanley Hiller, president of Hiller Helicopters Corporation, replied for industry in a timely speech that emphasized the keen interest of all the production men of the Bay City area in giving the Army their close coöperation.

In San Francisco thanks were particularly due to B. C. Heacock, chief of the Ordnance District, and Col. Calvin A. Heath, deputy district Ordnance Officer, and his staff for the splendid arrangements of the entire program.

The final appearance of the panel was at the Biltmore Hotel, Los Angeles. The principal sponsor here was the Quartermaster Association led by the president of its Southern California Chapter, Col. R. M. Petersen, who presided at the meetings. R. C. Geffs, president of the A.O.A. Los Angeles Post, had assisted materially to ensure a large attendance of A.O.A. members.

At the dinner meeting following the panel discussion Maj. Gen. Herman Feldman, president of the Quartermaster Association, congratulated the assembled members of all the associations and thanked the American Ordnance Association for its part in furthering the whole program.

Roy M. Hagen, president, California Consumers' Corporation, spoke on behalf of industry, in reply to Secretary Higgins' talk.

For the constant observer at every meeting there was never a dull moment. At the afternoon panel meetings throughout the trip each one of the standard questions on contracting read by the panel spokesman and answered by a panel member led to a flood of new and interesting questions propounded from the floor. In some cases these questions helped to clarify procedures in the minds of the audience; in others they presented matters to the Secretary and his staff that evidently required further investigation or pointed to the need for changes in the rules for handling contracts.

Another outstanding feature was Secretary Higgins' talk after each dinner meeting. His talk was based on the complex problem of Army Procurement in the face of the need to prepare for enormous increases in personnel and units scattered all over the world. In addition, Mr. Higgins pointed out the Army's responsibility for supply of subsistence and other materials to all armed forces under the new single-service procurement policy. His talk was made crystal clear by some excellent charts and graphs.

The A.O.A. Memorial Awards

In memory of Col. James L. Walsh, a founder and former president of the American Ordnance Association, and of Adm. W. H. P. Blandy, a former vice-president of the Association, awards will be presented annually to outstanding ordnance students at the U. S. Military and Naval Academies.

The 1956 Walsh Memorial Award—a Winchester Model 70 rifle, suitably inscribed.

THE Col. James L. Walsh Memorial Award was presented at the U. S. Military Academy by Vice Adm. George F. Hussey, Jr., president of the A.O.A., to Cadet Don E. Ackerman on June 3, 1956.

The award was established this year by the A.O.A. Board of Directors in memory of Colonel Walsh, president of the Association from 1947 until his untimely death in June 1952. He graduated from West Point in 1909 and was one of the most active advocates of the A.O.A. throughout his life. Colonel Walsh effectively spearheaded the program that gives the Association its present stability and strength in membership.

The award was designated to be given to the cadet of the graduating class with the highest rating in ordnance engineering. Cadet Ackerman, the first winner, is from Gothenberg, Nebr., and received his award at the annual Presentation Parade, a colorful and impressive ceremony on the Plains that brings stirring memories to all graduates of the Military Academy. The prize winner is now a second lieutenant in the Air Force.

Upon the recommendation of Academy authorities, a sporting rifle was selected as the most appropriate prize to give recognition to excellence in ordnance. This year a Winchester Model 70 rifle with a Lyman Alaskan 2½-power scope was chosen. It is beautifully engraved and sports a descriptive plate and a shield of the A.O.A., both on gold inlays.

Vice Adm. George F. Hussey, Jr., A.O.A. president, above, presents Walsh Award to Don E. Ackerman. Below, Lieut. Gen. Levin H. Campbell, Jr., past president, presents Blandy Award to T. J. Cronin, Jr.

THE Adm. W. H. P. Blandy Award was presented at the U. S. Naval Academy by Lieut. Gen. Levin H. Campbell, Jr., past president of the Association, to Midshipman Timothy J. Cronin, Jr., on May 29, 1956.

This was the first presentation of the Blandy Award since it was established in the fall by the A.O.A. Board of Directors. It serves to perpetuate the name of Admiral Blandy, a 1913 graduate of the Naval Academy, wartime Chief of the Navy Bureau of Ordnance, and a director and later vice-president of the American Ordnance Association from 1951 until his unexpected death in January 1954. He was a staunch supporter of the Association and a firm believer in close cooperation of the Army and Navy in Ordnance.

The Blandy award was appropriately designated for the graduating midshipman who leads his class in practical ordnance, a performance that requires outstanding leadership and keen understanding in all ordnance drills and practical work. Midshipman Cronin, who hails from Jamaica Plain, Mass., received his award at the Presentation Parade on Worden Field.

A shotgun was selected after consultation with Academy authorities as the prize best suited for an enthusiastic ordnanceman. This year a Remington Arms Sportsman 58 was chosen. It is a new gas-operated 12-gauge automatic with interchangeable 26- and 28-inch barrels. The piece was handsomely engraved and is inlayed with an appropriate inscription.

The 1956 Blandy Memorial Award—a Remington Arms Sportsman 58 engraved shotgun.

Iowa Ordnance Plant Is Host to the Container Committee at Burlington Meeting

The Container Committee, Bomb and Artillery Ammunition Division, met at Burlington, Iowa, on May 15-16, 1956. The technical session was held the first day at the Hotel Burlington with Harvey Simms, Cleveland Container Company, ably fulfilling his duties of Chairman of the Committee. About forty-five members and guests took part in the discussions, representing the packing and packaging industries and the several military services.

The host for the meeting was the Iowa Ordnance Plant, and the commanding officer, Lieut. Col. William Bobzien, and Brig. Gen. Joel G. Holmes, Mason & Hanger-Silas Mason Company, plant manager, welcomed the group to Burlington and to a tour of the Ordnance plant.

Chairman Simms opened the third meeting of the Container Committee and introduced the new Committee members and honor guests.

Brig. Gen. T. K. Vincent, staff consultant for Technical Divisions and Committees, outlined the A.O.A. technical activities and advised the Committee regarding policies and procedures.

The following program of papers was presented: "Observations of Ammunition Packaging in the Far East," George Buck, Picatinny Arsenal; "Guided Missile Packaging," Harold Decot, Craig Systems, Inc.; "New Developments in the Wooden Box Industry," C. D. Hudson, National Wooden Box Association; "Future Requirements of Army Ordnance Ammunition Items in General Terms," Ronald Basie, Ordnance Ammunition Command; "Recent Development in the Metal Can Industry," Carl G. Nesbitt, Continental Can Company; "Current Development Projects To Improve Ammunition Pack and Packing," Kenneth Macey, Ordnance Ammunition Center.

Also, "What's New in Pressure Sensitive Tape," Richard G. Breeden, secretary-manager, Pressure Sensitive Tape Council; "Recent Developments in Fiber Ammunition Container Packaging," Arthur J. Stokes, Picatinny Arsenal; "Air Force Ammunition Packaging Program," Albert Olevitch, Wright Air Development Center.

Also, "Ammunition Packaging in Field Service Depots," Chester V. Parker, Field Service, Office, Chief of Ordnance; "Loading Line Packaging of Ammunition," Perry Fulkerson, plant manager, Milan Ordnance Plant; "Developments in Packing of Ammunition at the Iowa Ordnance Plant," Mark H. Wegener, Mason & Hanger-Silas Mason Company.

The Committee and guests had a social hour and dinner following the technical session. The second day of the meeting was devoted to a tour of the Iowa Ordnance Plant as guests of Colonel Bobzien and General Holmes. The Iowa Ordnance Plant is contractor-operated by Mason & Hanger-Silas Mason Company.

Preservation, Packing and Packaging Division Meets at Picatinny Arsenal

About forty members and guests of the Preservation, Packing and Packaging Division met at the call of Chairman John W. Kraus, Accessories Division, Thompson Products, Inc., at the Picatinny Arsenal, Dover, N. J., on May 23, 1956. This was an unclassified meeting, and a number of interesting and instructive papers were given.

Col. I. O. Drewry, Ordnance Corps, Arsenal Commander, was unable to be present at the meeting due to illness but was ably represented by Ray Wood, chief of the Artillery Ammunition and Packing Development Laboratory, Samuel Feltman Ammunition Laboratories, who welcomed the group to Picatinny Arsenal and expressed Colonel Drewry's regrets.

In the absence of N. L. Ripich, American Tank and Fabricating Company, and R. F. Weber, Medium Materials Handling, chairmen of the Production and Equipment Committee and the Materials Committee, respectively, the Division chairman introduced and monitored the papers presented for their Committees.

After luncheon the conferees were divided into three groups and conducted on a tour of the Package Testing Laboratory, Samuel Feltman Ammunition Laboratories, which gave an insight into the thoroughness and effective manner in which ammunition containers are tested.

Papers were presented for the Materials Committee on the subject of "Problems of Materials for Military Packaging," by Milton A. Raun, deputy chief, experimental division, Chemical Corps Research and Development Command, and "Changes in Desiccant Specifications and New Humidity Indicators," by Eldon H. Gleason, Jr., desiccant division, Culligan, Inc.

Papers presented for the Production Equipment Committee were on the subject of "Mechanical Equipment for Packaging," by Alex Donaldson, Minnesota Mining and Manufacturing Company, and "Navy Packaging" by Seymour Stambler, head of the packaging and preservation branch, Supply Engineering Division, U. S. Naval Supply, Research and Development Facility.

Papers presented by the Container and Material Testing Committee were on "Development of a Pliability Tester for Barrier Material," by Howard M. Weiner, chief of the packing materials unit, Packaging Section, Samuel Feltman Ammunition Laboratories; "Testing of Fiberboard," by Alfred W. Hoffman, Robert Gair, Inc.; and "Paperboard Containers" by L. R. Ayres, Robert Gair, Inc.

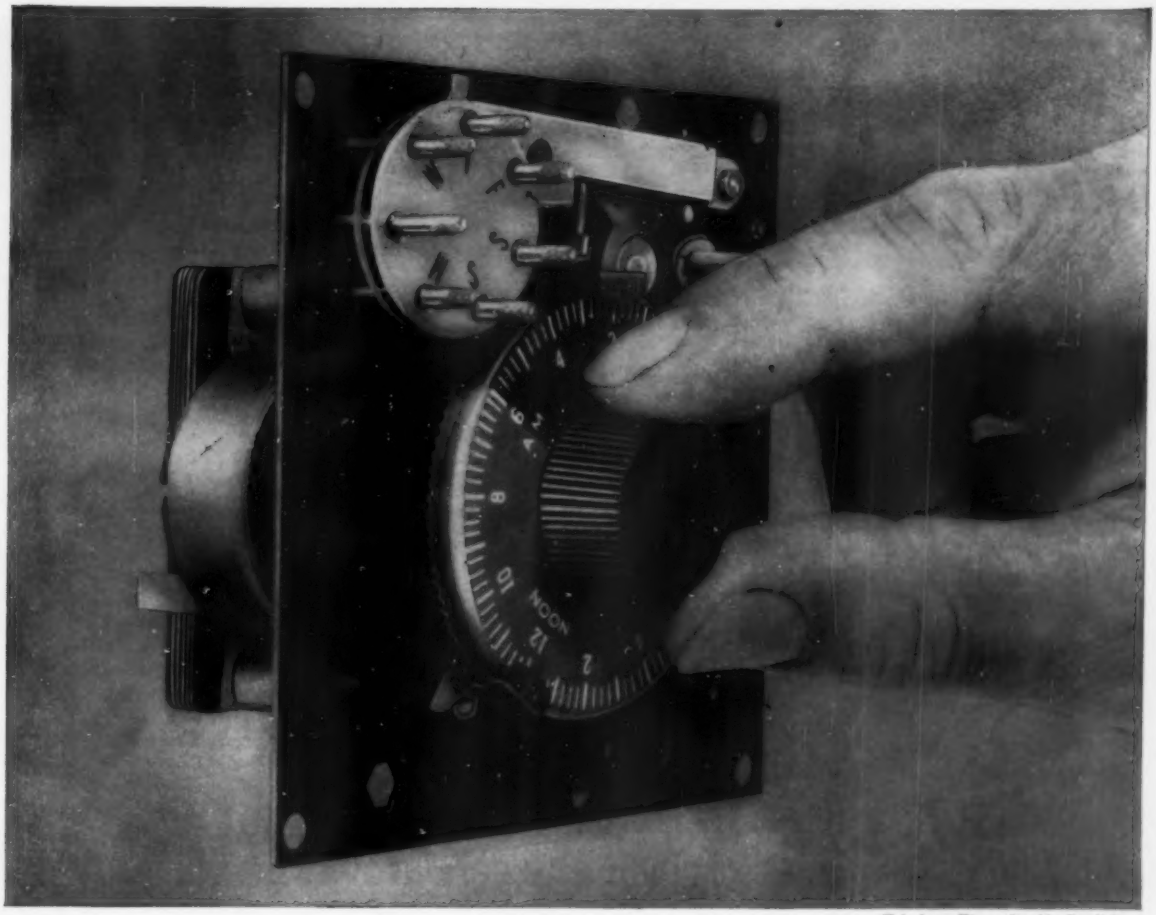
Papers were presented for the Methods Committee on "Reëvaluation of Protective Level for Air Force Packaging," by A. R. Brown, Wright-Patterson Air Force Base, and "Adventures in Export Packing," by A. D. Peister, General Motors Overseas Operations.

This Division covers the entire field of ordnance activities, and all Divisions and Committees should avail themselves of its services in solving their problems. The Division is anxious to serve the Army, Navy, and Air Force as well, and already the Division chairman has referred several Air Force problems to appropriate Committees with helpful solutions having been submitted to the Air Force for further consideration and action.

New Electronics Division Holds Its Inaugural Meeting at Syracuse, N. Y.

About sixty-five members and guests of the Electronics Division held their first meeting since their elevation to Division status on May 24-25, 1956. The classified meeting was held at Electronics Park, Syracuse, N. Y., where the Division was the guest of the General Electric Company. The vice-president of General Electric in charge of its Electronics Division, Dr. W. R. G. Baker, is also chairman of the A.O.A. Electronics Division.

All sessions were held in the main auditorium of the General Electric Company. The Division was welcomed by Dr. Baker, and the preamble to the A.O.A. constitution and prescribed portions of the policies and procedures governing Technical Divisions and Committees were read by Brig. Gen. T. K. Vincent, U.S.A. (Ret.), staff consultant for Technical Divisions and Committees from A.O.A. headquarters. (*Continued on page 264*)



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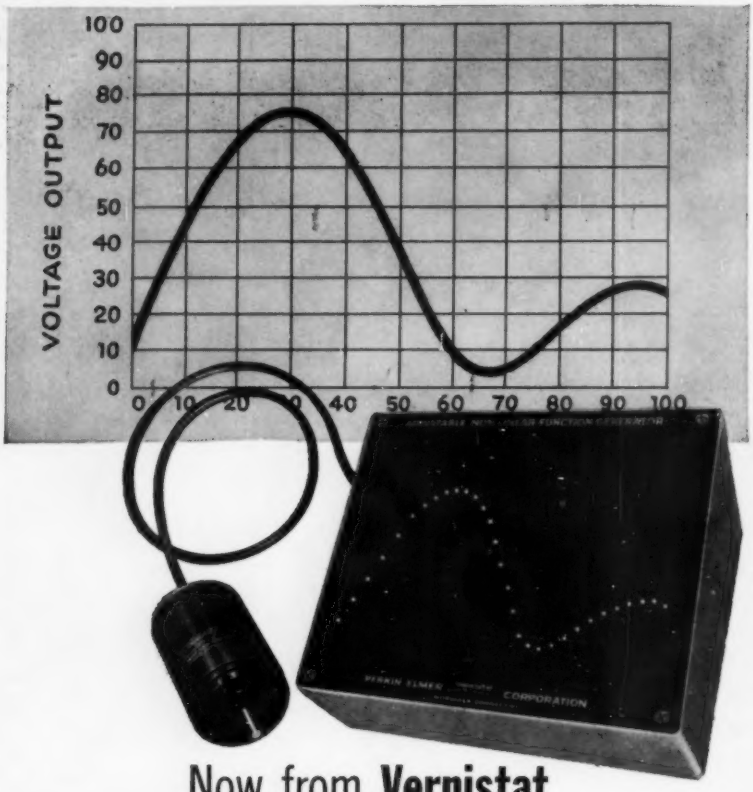

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Division Activities

M. D. Lockwood, Sperry Gyroscope Company, chairman of the Ground and Shipborne Committee of the Division, was program chairman and introduced the speakers. The theme of the meeting was "Practical Approaches to Reliability of Surface Electronic Equipment."

Maj. Gen. S. P. Wright, U.S.A.F., commander of the Rome Air Development Center, Griffiss Air Force Base, N. Y., discussed the Air Force approach to the theme.

Capt. J. L. P. McCallum, U.S.N., chief of the Guided Missiles Branch, Research and Development Division, Bureau of Ordnance, presented the Navy viewpoint, illustrating his talk with numerous personal experiences in this connection.

Lieut. Col. J. P. Hamill, Ordnance Corps, chief of the Ordnance Mission, White Sands Proving Ground, discussed the Army problems, gave a firsthand account of the recent Nike tests at White Sands, and outlined the Ordnance Mission organization and function.

G. M. Armour, General Electric Company, discussed "Progress in Electronic Systems Reliability."

The entire group were guests of the General Electric Company at luncheon in the dining room at Electronics Park. Following luncheon, the afternoon session covered the following subjects and speakers:

"Reliability Engineering in Fire Control System Development," P. W. Vestigo, Sperry Gyroscope Company.

"Progress in Improving Reliability of Electronic Equipment for the U.S.A.F.," F. Moskowitz, Rome Air Development Center.

"Laboratory and Field Experience with Army Issue Ground Signal Equipment," W. J. Laverick, Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

"Computer System Reliability," L. L. Bock and M. Macauley, Remington Rand Univac Division, Sperry Rand Corporation.

A dinner was held at Martins in Syracuse at which Dr. Baker spoke on the general subject of "Military Principles Applied to Industry Planning."

The second day was taken up with papers on "Transistors," by J. H. Hershey, Bell Telephone Laboratories, and "Application of Ceramics to Vacuum Tubes," by R. E. Manfredi, General Electric Company.

The meeting closed with a tour of the Radio and Television Department at Electronics Park.

Now that the Electronics Division has had its first general meeting, it is expected that the Committees of the new Division will hold separate meetings in the future as required. (*Continued on p. 266*)

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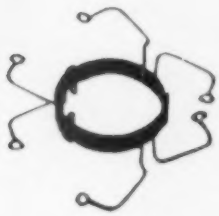

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Eighty Members Attend Meeting of Guided Missile Branch at Tullahoma, Tenn.

The Guided Missile Branch, Guided Missile and Rocket Division, under the chairmanship of C. L. Eksergian of the Budd Company, met at the Arnold Engineering Development Center, Tullahoma, Tenn., on May 9-10, 1956.

This Branch consists of three very active Committees which meet concurrently with each other and jointly for the Branch sessions. The Committees are Guidance and Control, Daniel E. Noble, Motorola Corporation, chairman; Propulsion, C. M. Guy, Rocketdyne Division, North American Aviation, Inc., chairman; and Structures, Elmer P. Wheaton, Douglas Aircraft Company, chairman.

About eighty members and guests met for the classified sessions. All were housed in the motels near the AEDC. The facilities of the Officers' Club, located on Wood's Reservoir, were thoroughly enjoyed by all for luncheon and dinner each day.

The group was welcomed by Col. John T. Trotter, U.S.A.F, vice-commander of AEDC, in the absence of Maj. Gen. S. R. Harris, U.S.A.F. His remarks as to the availability of assistance from his staff were already attested to by those present, as the many details in connection with reception, transportation, housing, feeding, etc., had all been anticipated and everything ran with the utmost precision.

Chairman Eksergian opened the joint session of the three Committees and outlined the scope of the meeting which covered "Service Evaluation of Guided Missiles."

The three military services presented classified papers on pertinent subjects.

The presentation for the Army was given by Col. B. J. L. Hirshorn, Ordnance Corps, deputy for technical operations, White Sands Proving Ground, on the subject, "Operation Problems Revealed by Test."

The Navy presentation was given by Capt. Mason Freeman, U.S.N., Operational Development Force, on the subject, "Force Difficulties Encountered in the Service Evaluation of Regulus, Sparrow, Terrier, and Sidewinder."

The Air Force presentation was given jointly by Col. Robert L. Johnston, U.S.A.F., Deputy Director, Research and Development, U.S.A.F., and Maj. H. R. Robinson, U.S.A.F., project officer, Matador Missile System, Air Matériel Command, on the subject, "Experiences of North African Maneuvers."

After luncheon the three Committees met separately. The Guidance and Control Committee had a presentation on "Producibility" by C. W. Reynolds, assistant manager, North Carolina Works, Western Electric Company. The other Committees discussed pertinent problems after which business meetings were held.

In the evening a refreshment hour was held at the Officers' Club, AEDC, followed by an excellent dinner. The membership of the Branch was augmented by guests from AEDC and Aro, Inc. A contingent from the Redstone Chapter of the Birmingham Post, A.O.A., joined the group.

Brig. Gen. T. K. Vincent, staff consultant for A.O.A. Technical Divisions and Committees, acted as toastmaster. Tributes were paid to Lieut. Col. Wm. G. Downey, U.S.A.F., and Col. Robert L. Johnston, U.S.A.F., both of whom did superior work in planning the meeting.

Jess Hadley, Bendix Corporation, secretary of the Branch; Ed Meissner, consulting engineer; and Rear Adm. Malcolm Schoeffel, General Precision Equipment Corporation, were all praised and roundly applauded for their fine work.

Stan Donnelly, Western Electric Company, local chairman in charge of the meeting, was recognized for an outstanding job in handling the many details in this connection. Capt. Jack Olsen, U.S.A.F., project officer; Capt. K. C. Witt, U.S.A.F., transportation officer; and Lieut. J. K. Huebner, U.S.A.F., housing and mess officer, all of the AEDC staff, were accorded the thanks of every one.

Tribute was paid to Col. Leslie A. Skinner, who was present as a member of the Propulsion Committee, for his pioneer work in Rocketry in the Army, and for his development of the bazooka in the late 1930's.

The guests at the speakers' table included: Col. John T. Trotter, U.S.A.F., vice commander, AEDC; Brig. Gen. H. N. Toftoy, commanding general, Redstone Arsenal; Rear Adm. F. S. Withington, Chief of the Navy Bureau of Ordnance; Gen. Thomas F. Farrell, managing director, Aro, Inc., the operating contractor of AEDC.

General Toftoy spoke briefly on the Army rôle in the guided-missile activity. Admiral Withington spoke for the Navy and gave a number of salient points that must be considered in future missile activities. He cordially invited the Guided Missile Branch to hold its next meeting at the Naval Ordnance Test Station, China Lake, Calif., in the fall, which invitation was promptly and resoundingly accepted.

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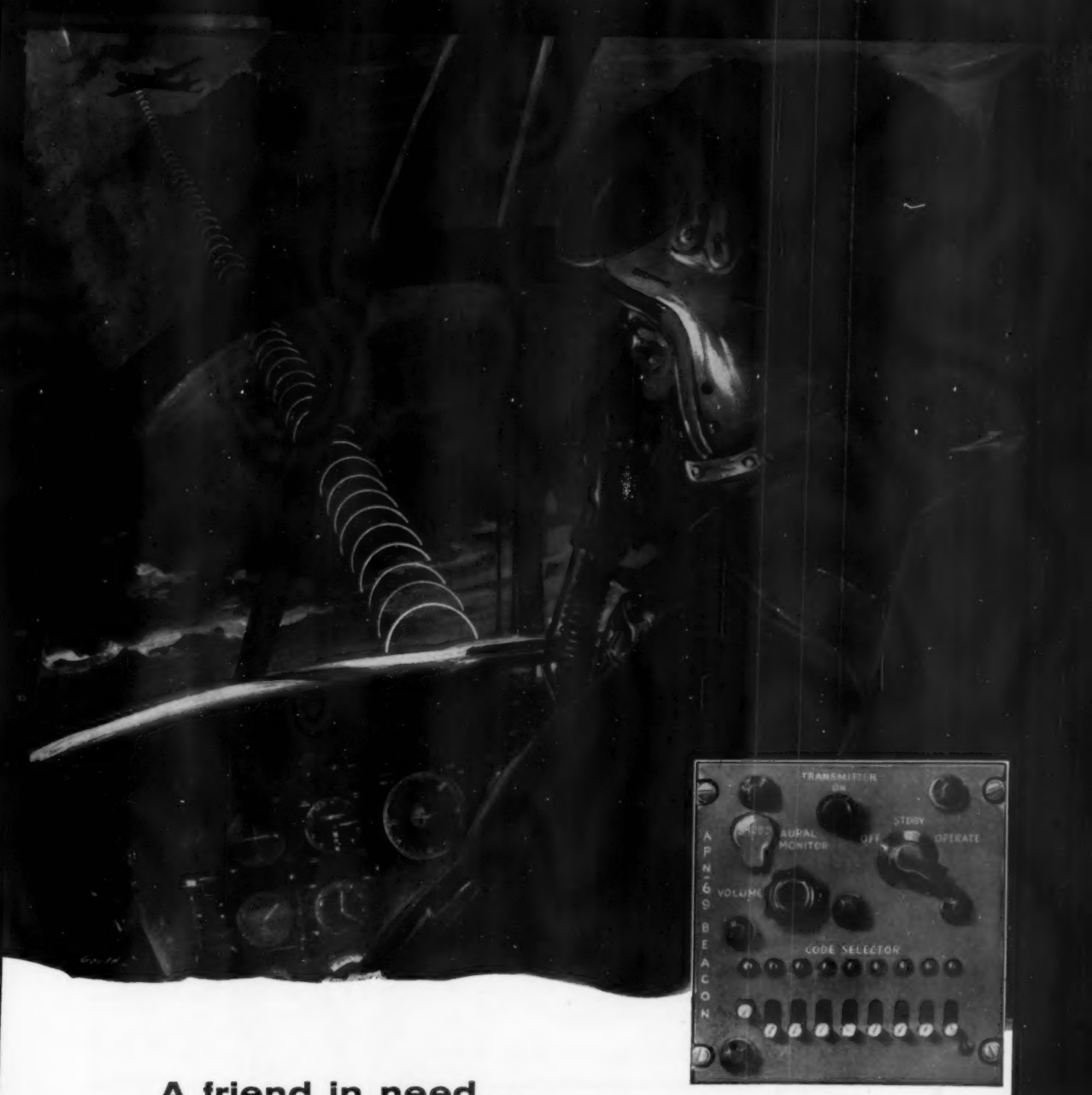

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The most satisfactory method of supplying a GOOD PRODUCT to the consumer is in a distinctive, properly designed and constructed container.

AC Spark Plug chose a CLEVELAND CONTAINER to package their tachometer. This sensitive instrument is adequately protected in a convenient, attractively labeled container. This is typical of the countless packaging problems competently handled by our designers and engineers.

Have you a packaging problem? The answer may lie in the wide range of Cleveland Containers . . . or in one specially designed to fit your product.

* * *

Write the plant nearest you for our complete packaging folder.

Why pay more? For Good Quality . . . call CLEVELAND!

THE **CLEVELAND CONTAINER** COMPANY

6201 BARBERTON AVE., CLEVELAND 2, OHIO

PLANTS AND SALES OFFICES: CLEVELAND, DETROIT, CHICAGO, MEMPHIS, LOS ANGELES, PLYMOUTH, WIS., JAMESBURG, N. J., OGDENSBURG, N.Y. • ABRASIVE DIVISION CLEVELAND

SALES OFFICES: NEW YORK CITY, WASHINGTON, D. C., ROCHESTER, N. Y., WEST HARTFORD, CONN.

• ALL-FIBRE CANS • COMBINATION METAL AND PAPER CANS • SPIRALLY WOUND TUBES AND CORES FOR ALL PURPOSES

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Division Activities

Col. Wm. L. McCulla, U.S.A.F., former vice commander of AEDC and now special assistant to the commanding general, AEDC. His subject was the "Rôle AEDC Plays in the Guided Missile Program."

The second day of the meeting was devoted to a briefing by Aro, Inc., representatives on the various activities and facilities at the Center, followed by a conducted tour.

Powder Metallurgy Committee Holds Summer Meeting at Colonel Tholand's Estate

Fifty-five industry members and armed forces consultants of the Association's Powder Metallurgy Committee attended the summer meeting of the Committee on May 16, 1956. A. J. Langhammer, chairman of the Committee and president of Amplex Division, Chrysler Corporation, Detroit, presided.

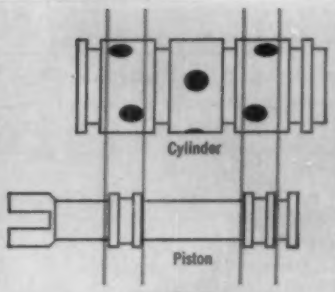
The meeting was held at Piedmont, near Sperryville, Va., the country estate of Col. N. K. G. Tholand.

Col. Leo A. Codd, executive vice-president of the Association, expressed the appreciation of the A.O.A. to Mr. Langhammer and to Colonel Tholand as well as to all members of the Committee for their participation and interest.

The sessions of the Committee followed luncheon which was served by the lake on the estate. At the meeting, industrial reports were presented by Committee members, representing various phases of the powder metallurgy industry. A. Allen spoke on "Copper Powder"; B. T. duPont of National Radiator Company on "Statistics Regarding Iron Powder"; William Batten of Vanadium Alloy Steel Company on "Stainless Steel and High-Temperature Powders"; Dr. H. H. Hausner of the Nuclear Engineering Division, Penn-Texas Corporation, on "The Rôle of Powder Metallurgy in Nuclear Engineering." Rodney Harper and Mr. Norton also presented papers.

Papers were also presented by: Warren Blittersdorf of Frankford Arsenal on "Rotating Bands of Iron Powder and Gilding Metal Powder"; Joseph Dubin of Picatinny Arsenal on "Applications of Powder Metallurgy to Ammunition Development"; Bennett Bovarnick of Watertown Arsenal on "New Inspection Methods (electrochemical) for Iron Powder"; Earl H. Abbe of Springfield Armory on "Needs and Requirements of Iron Powder Parts for Small Arms"; and Robert Ridgway of Army Ordnance Ammunition Command, Joliet, Ill., on "Metal Powders as Used in Ammunition."

MATCH PISTON LANDS TO CYLINDER PORTS PRECISELY WITH SHEFFIELD'S MICRO-FORM GRINDER



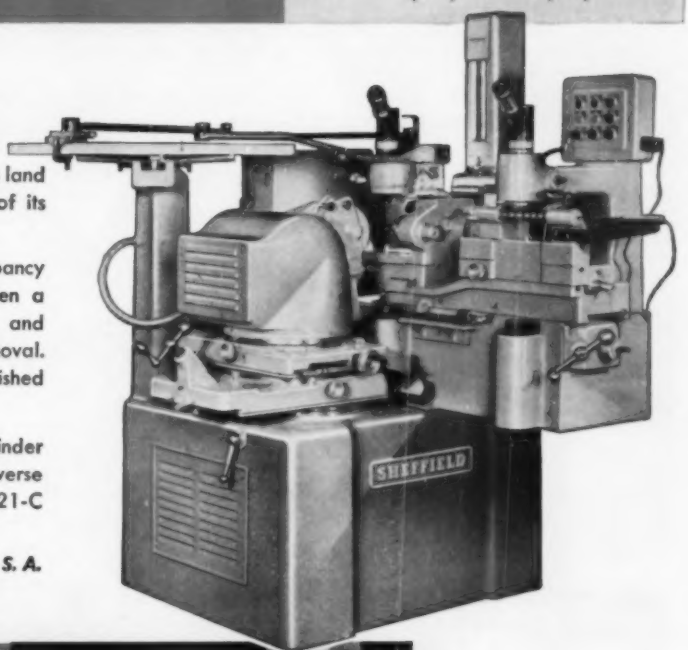
This servo cylinder and piston are typical of the very precisely machined hydraulic components in aircraft propeller and flight control systems.

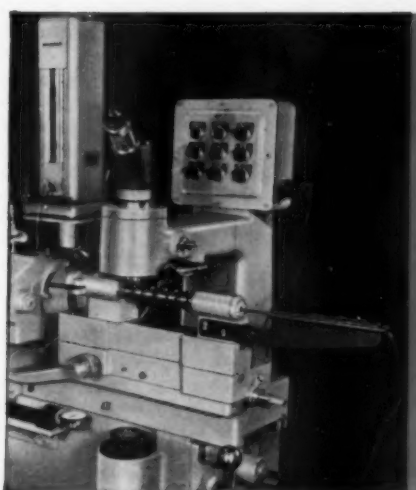
With the actual cylinder as a reference, each piston land is individually ground to match the inside edge of its respective cylinder port.

If a flow test then reveals the slightest discrepancy between land and port edge, the piston is given a finishing touch, using a Sheffield Precisionaire and Airetest Indicator to show progress in stock removal. Thus, the correction of the land face can be accomplished to within ± .000010".

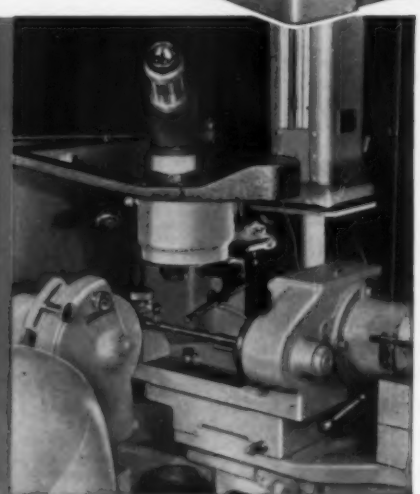
This is typical of the wide range of Micro-Form Grinder applications in duplicating precision profiles or reverse profiles from a master. Write for Bulletin MFG-121-C to Dept. 14,

THE SHEFFIELD CORPORATION, DAYTON 1, OHIO, U. S. A.





Cylinder under observation on auxiliary table.



Airetest Indicator shows stock removal in final correction.

7560

GOLDEN ANNIVERSARY

SHEFFIELD

manufacture and measurement for mankind

• **THOMAS J. WATSON, SR.,** chairman and former president of International Business Machines Corporation, New York, and a member at large of Council of the American Ordnance Association, died on June 19, 1956. He had served on the Council for a number of years and was a strong supporter of the Association's national-defense objectives.

Born at Campbell, N. Y., in 1874, Mr. Watson attended the Elmira School of Commerce. His long service in the field of business machines began with the National Cash Register Company, of which he became general sales manager. In 1914 he was chosen to head the Computing-Tabulating-Recording Company which later became the International Business Machines Corporation.

Together with other important units of the calculating machine industry, Mr. Watson gave his wholehearted support—research and productionwise—to the needs of the defense services for the provision of calculating machines as an integral part of weapons development. Indeed, the research laboratories of industry have become a basic element in the development of weapons systems to meet the needs of the missile-air-atomic age.

Throughout this period the guidance and zeal of Mr. Watson were of inestimable value. His farseeing vision and energy brought to the problem the vast resources of one of the world's leading industrial organizations. He typified the highest qualities of leadership and patriotism in this as well as in many other civic, philanthropic, and religious causes. His name will always be associated with achievement and human relations, national and international. His emphasis of the motto, "Think," will long remain a symbol of his greatness.

• **CARL J. SNYDER,** vice-president and operating manager of Chrysler Corporation and a life member of the American Ordnance Association, died in the crash of two airliners in Grand Canyon on June 30, 1956.

Since his earliest days Mr. Snyder had been directly associated with automobile manufacturing—the past thirty years with Chrysler Corporation and its predecessor, the Maxwell Company. He was an early associate of Walter P. Chrysler and from 1928 was master mechanic of one or another of the vast Chrysler manufacturing plants or served in high capacity on the staff.

World War II called forth Mr. Snyder's greatest ability as a skilled planner of new plants. He planned and directed the tooling of two plants for Chrysler's part in the Manhattan District—the atomic-bomb project—and also the Dodge Chicago Plant in 1944 where combat and transport vehicles were produced for the Army.

His vast experience and great knowledge of production and tooling and his tremendous energy were an inspiration to all his associates. His untimely death is a great loss to the automotive industry and his many friends in ordnance.

• **COL. HOWARD N. WILLOUGHBY,** a life member of the American Ordnance Association and a distinguished Army Ordnance officer in the Second World War, died at his summer home in Ludington, Mich., June 21, 1956. He was a native of Mt. Sterling, Ohio, and for many years resided at Richmond, Ind.

After eleven years in the banking business at Cleveland and Detroit, Colonel Willoughby became associated with the Chevrolet Motor Division of the General Motors Corporation with which he served for eight years. In 1940 he became head of Willoughby Chevrolet Company of Richmond.

In 1942 he became a major in the Ordnance Department of the Army, serving as assistant chief of the industrial division of the Rochester Ordnance District. He remained on active service until December 1, 1945. Thereafter, he devoted much of his time to his duties as a Reserve Officer, becoming commander of the 308th Ordnance Group of the Second Army.

• **COL. EDWARD BERGMAN,** an active participant in the First and Second World Wars and long a member of the American Ordnance Association, died at Orlando Air Force Base Hospital, Orlando, Fla., on May 19, 1956. He was in the First Expeditionary Brigade, A.E.F., in World War I and throughout World War II was Ordnance Supply Officer at New Cumberland General Depot, New Cumberland, Pa.

Colonel Bergman was born in Stettin, Germany, and came to the United States at the age of 10. He enlisted in the 4th Field Artillery, serving at Fort D. A. Russell, Wyo., and Fort Barrancas, Fla., prior to going overseas in World War I where he served as brigade sergeant major.

His award of the Victory Medal included citations for service in the Champagne-Marne defense, the Aisne-Marne, St.-Mihiel, and Meuse-Argonne offensives.

Following the war he served as an enlisted member of the Ordnance Department of the Army at various stations in the United States and the Philippine Islands. He retired from active duty in 1947, residing at Winter Park, Fla.

SAVE MONEY... TIME... SPACE
PRINT YOUR BOXES AS YOU PACK 'EM

Gottscho MARKOPRINTER machine prints wood, metal, plastic boxes on the production line

The first practical answer to in-plant printing of completely assembled boxes—large and small—this machine is now effecting huge savings in ordnance plants throughout the country. The MARKOPRINTER machine prints all identification copy and changeable dates, weights, lot numbers on all four sides and top of boxes simultaneously . . . *automatically* . . . as part of the packing operation. Works on all kinds of boxes—with or without rope grabs, cleats, wire straps, etc. Eliminates labor cost for marking, and supply problems; reduces unit cost of boxes, inventory and space requirements.

Write for full details today

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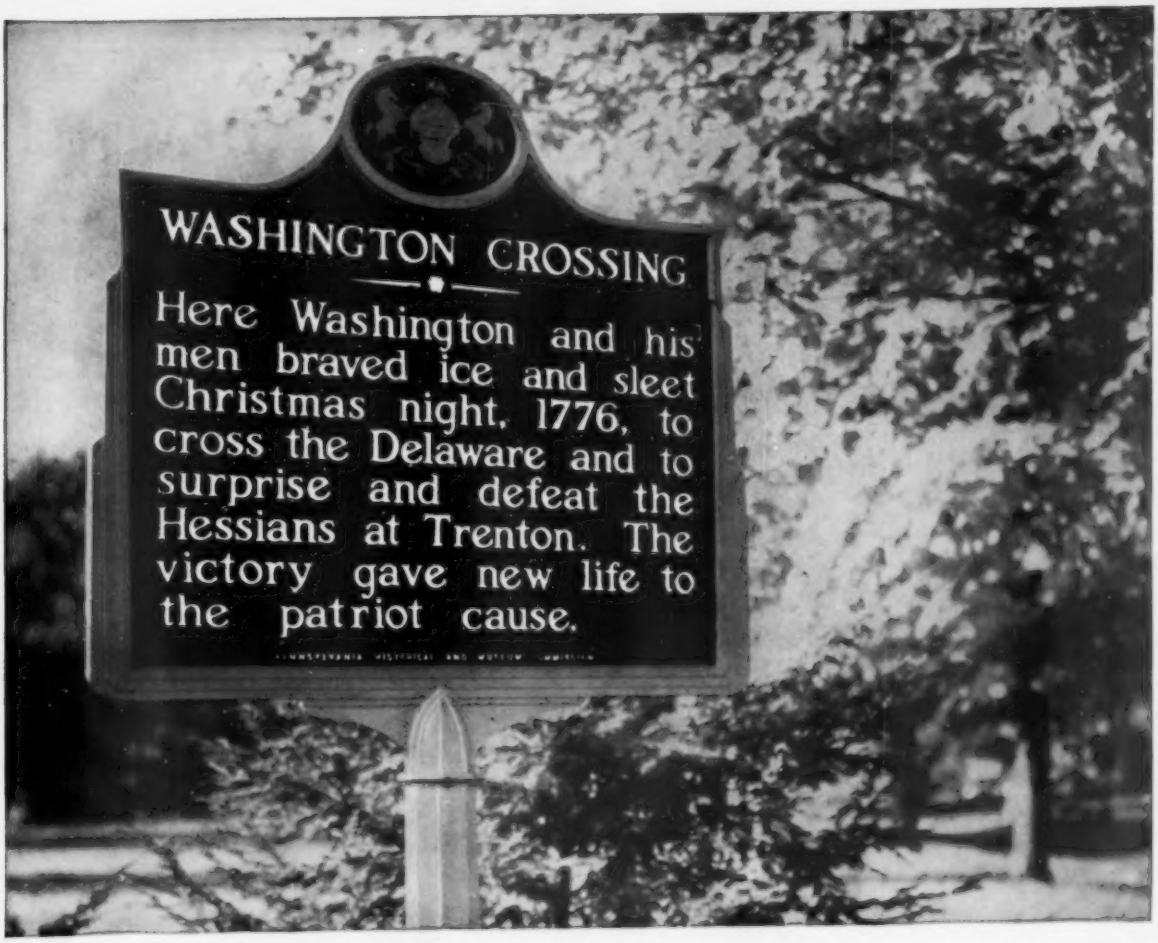
Automatic Production-Line
CODING, MARKING IMPRINTING MACHINES


WASHINGTON CROSSING
Here Washington and his men braved ice and sleet Christmas night, 1776, to cross the Delaware and to surprise and defeat the Hessians at Trenton. The victory gave new life to the patriot cause.

Signpost to a nation's greatness

Freedom's cause never ebbed among the courageous patriots of Washington's army. Today, this sign post stands as mute testimony to an unflinching courage, a dedication to an ideal more precious than life itself. "Peace at any price" they scorned as unworthy the heritage of free men. Craven weakness in the face of oppression they looked upon with contempt. Abandonment of principle was unthinkable! They started America upon the path of greatness. It is our duty in this era of Communist conspiracy to hold fast to these traditions of honor and nobility they have willed us.

W B Stuart

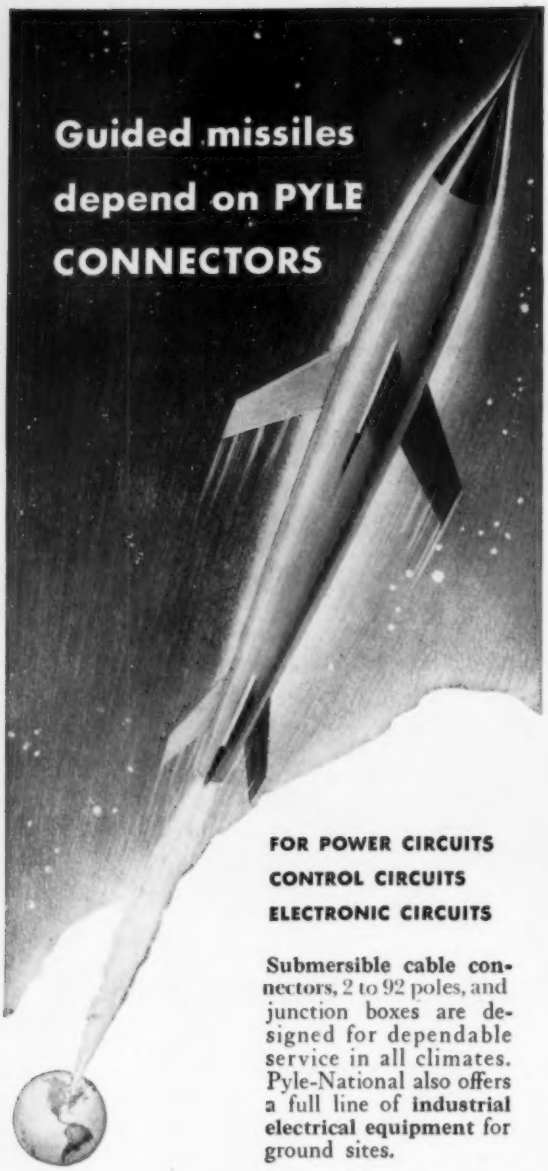
PRESIDENT

DUTY HONOR COUNTRY
LABOR BUSINESS GOVERNMENT

The **GRAY** Manufacturing Company, Hartford 1, Conn.

Audograph, PhonAudograph and Telephone Dictation Systems

and Gray Research & Development Co., Inc., Specialists in Video, Audio and Electro-mechanical Devices



FOR POWER CIRCUITS
CONTROL CIRCUITS
ELECTRONIC CIRCUITS

Submersible cable connectors, 2 to 92 poles, and junction boxes are designed for dependable service in all climates. Pyle-National also offers a full line of **industrial electrical equipment** for ground sites.

Please direct inquiries to: Manager of Special Products.

SINCE 1897

THE PYLE-NATIONAL COMPANY
Where Quality is Traditional
1371 North Kostner Avenue, Chicago 51, Illinois

NEW DEVELOPMENTS

NEW CORPORAL MISSILE

The Army's Corporal guided missile is being replaced by "Corporal 2." The new missile looks almost exactly like its predecessor, and apparently its range is the same, but the betterment of the old model's efficiency is announced as "significant."

The old erector has been replaced by one with much better powering to enable the device to be moved more rapidly from storage to launching point over any kind of terrain. Other items in the servicing equipment also have been bettered to provide greater speed.

VERTICAL TAKE-OFF CRAFT

Contracts for the design and development of flying test beds for two new vertical take-off and landing (VTOL) aircraft were recently announced by the Department of the Army.

One was awarded to the Vertol Aircraft Corporation, Morton, Pa., for a tilt-wing, turbine-powered, vertical take-off and landing aircraft. In hovering flight the tiltable wing is in the vertical position, and the rotor-propellers provide vertical thrust, as in a helicopter. In cruise and high-speed flight the wing is in the normal horizontal position.

Vertiplane's flaps will divert slipstream for vertical flight.

The second contract was with the Ryan Aëronautical Company, San Diego, Calif., for a deflected-slipstream, turbine-powered, vertical take-off and landing aircraft, called the "Vertiplane." It employs large propellers and double retractable wing flaps.

Scheduled to be powered by a single gas turbine which will drive two propellers, the Vertiplane embodies a conventional configuration except for the wing, which incorporates the large double retractable flaps located in such a way that the propeller slipstream can be deflected ninety degrees downward during take-off, hovering, and landing. For transition into horizontal flight, the flaps are retracted as the craft picks up forward speed, and the slipstream then flows horizontally.

5,000-TON ATOMIC SUB

The largest submarine ever to be built, a twin-reactor undersea giant weighing more than 5,000 tons, is under construction for the Navy's all-atomic powered task force of the future. It will be named the U.S.S. TRITON.

Outstripping the lethal NAUTILUS by some 2,000 tons, the huge radar picket boat will be driven by two uranium-fueled furnaces to enable it to keep pace with the nuclear-powered guided-missile cruiser and carrier planned for the fleet. (*Continued on p. 274*)

SURE, POWER STEERING MAKES THE JOB EASIER. BUT IT'S THE ADDED SAFETY THAT COUNTS MOST.
OUR POWER-STEERED RIGS STAY ON SCHEDULE BETTER, TOO.
EITHER WAY, POWER STEERING MAKES GOOD BUSINESS SENSE.

THE CASE FOR POWER STEERING ON TRUCKS!

The trend to power steering on trucks is based on one very practical reason—operators of trucks equipped with power steering have invariably found that the added safety and greater operating efficiency of their vehicles have demonstrated that power steering is indeed a sound investment.

Truck drivers using power steering report less tension and fatigue in normal driving and appreciate the positive control that blocks road shock from chuck holes and prevents loss of control if the truck is forced out on a soft shoulder.

The dispatcher knows the importance of regularly maintained schedules. He is quite aware that with power steering drivers are more relaxed and are better drivers than tired drivers. Thus, power steering not only reduces the hazard of road accidents, but helps the driver to maintain established schedules through better vehicle control.

In short, power steering, by saving time and money, contributes materially to a more profitable operation.

Truck manufacturers are always eager to offer their customers features that will make truck operation safer and more profitable and, at the same time, give their dealers every selling advantage.

That's why more and more truck manufacturers are offering performance-proven Bendix Power Steering as original factory equipment.

If you would like to know why power steering for trucks is perhaps even more logical than power steering for passenger cars, we have prepared an interesting folder on the subject.

Write for your copy today. We think you'll be convinced.

Bendix PRODUCTS DIVISION South Bend IND.

Bendix AVIATION CORPORATION

New Developments (Contd.)

Being built for the Navy by the Electric Boat Division of the General Dynamics Corporation at Groton, Conn., the submersible is designed to scout the course of the task force to warn against approaching air, surface, and underwater threats. The new vessel tops the size of any previous submarine in order to house the two atomic power plants.

REMOTE CONTROL 'COPTER

A lightweight helicopter that flies by remote control from a ground station or another helicopter has been unveiled by the Army and Navy.

Designed for the two services by the Kaman Aircraft Corporation, Bloomfield, Conn., the versatile craft can perform a wide range of military missions. Equipped with TV camera and transmitter it could give combat commanders a running view of battlefield action and movement behind enemy lines.

It can lay communication wires rapidly over rugged terrain; carry cargo and supplies to otherwise inaccessible areas; drop smoke bombs to mark targets for artillery fire; and is highly maneuverable against such land vehicles as tanks.

It can also uncoil a line of explosive charges through an area spotted with enemy mines, exploding the charges as it goes, thus clearing a path for troop and vehicle movement.

IMPROVED SONAR

A recent development by General Electric Company will considerably increase the efficiency and effectiveness of U. S. Navy sonar equipment.

It consists of a new type of sonar transducer element made of barium titanate, a nonstrategic material with increased ability to handle underwater sound energy, as compared with strategic materials (such as nickel) which were previously used. The transducer element is the heart of sonar which emits electrical energy in the form of underwater sound signals and then picks up subsurface reflections.

Immersing sonar elements in test tank.

NEW TACTICAL BOMBER

The Martin Company of Baltimore, Md., has been selected to develop a new tactical bomber for the U. S. Air Force. In August 1955 the Air Force announced a competition for the development of a tactical bomber and awarded contracts to support that competition. This plan for the procurement of new aircraft was the result of intensive study to determine the best way to shorten the development cycle and ensure as great a performance gain as possible in the production of new aircraft. Phase I has now been completed, with Martin Company competing successfully.

ASP RESEARCH ROCKET

A high-speed rocket, Asp, especially designed for studies of the upper atmosphere, has been successfully field tested by the Navy. The rocket, named from the initials of "atmosphere sounding projectile," will be used to gather weather information, study cosmic-ray emanations and other geophysical data. The Asp will be used by the Naval Radiological Defense Laboratory.

The rocket has a diameter of 6½ inches

Built to take the shock of rock!

GarWood -St.Paul-

STRONG-ARM HOISTS AND BODIES

Load out bigger legal payloads with Gar Wood-St. Paul equipment. Rugged body design to take the shocks of shovel loading in rock . . . stress tested to put the strength where it's needed, eliminating excess weight.

Dump faster with greater safety regardless of load distribution. Torque tube converts thrust of twin-cylinder Strong-Arm hoist to equal lifting-power on both sides of dump body. No one-sided dumping strain . . . greater stability on rough grades.

Cut maintenance time and costs by standardizing on Gar Wood-St. Paul equipment. Strong-Arm hoists are the world's easiest to maintain. You can make necessary repairs with ordinary truck tools! Exclusive tie-rod cylinder design speeds up inspection and maintenance. Hydraulic pump is precision-machined for easier field servicing.

Call your Distributor for complete data and specifications. Or, write to Customer Service Dept., Gar Wood Industries, Inc., Wayne, Michigan.

GAR WOOD INDUSTRIES, INC.

Wayne, Michigan • Richmond, California

Gar Wood Load-Packers

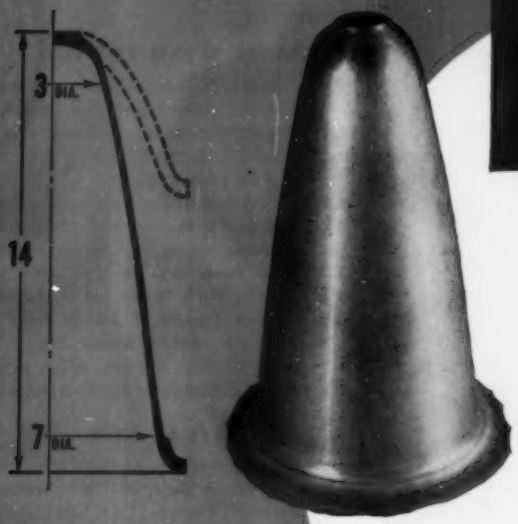
Gar Wood Truck-Mounted Cranes

Gar Wood Winches

Gar Wood-St. Paul Hoists & Bodies

HEMISPHERES TO 38" DIAMETER,

with 3/8" max. wall thickness, are readily formed on the Cincinnati Hydrospin. Part wall can be tapered or have constant thickness. The starting blank is a flat disk or dished preform. Almost any ductile metal can be used. Other machines available for parts and hemispheres larger than 38".



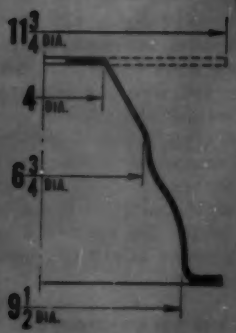
PARABOLIC-SHAPED PART

formed in one pass in two minutes. Starting blank of 61 SO aluminum, 11 3/8" dia. x 3/16" thick, was preformed on a Cincinnati Hydroform.

complicated contours cost less by Hydrospinning!

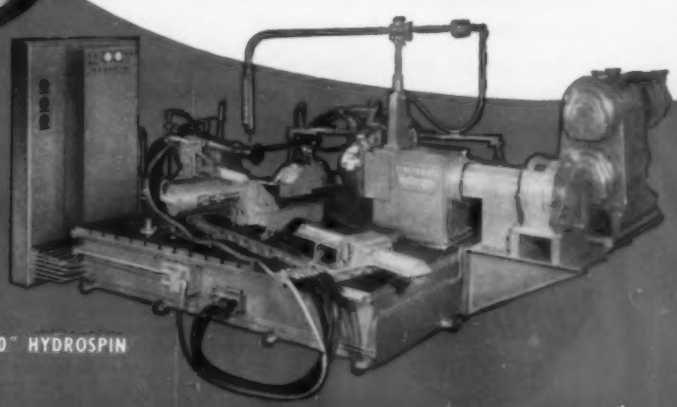
The parts shown here were formed by *tracer* Hydrospinning at substantial reduction in cost over that of previous production methods. These parts were produced in far less time . . . are more accurate . . . have increased strength with greater resistance to fatigue failure . . . required less material . . . and were made without compromising on material requirements.

If difficult-to-form contoured components are one of your production headaches, get the facts on Hydrospinning. Call in a Cincinnati Milling field engineer. For a detailed description of the process and machine specifications, write for new Bulletin M-1873-2.



COMPOUND CONTOURS

of this part were formed in one pass in one minute. Material is mild steel.



CINCINNATI 42" x 50" HYDROSPIN

CINCINNATI **Hydrospin**

PROCESS MACHINERY DIVISION
THE CINCINNATI MILLING MACHINE CO.
CINCINNATI 9, OHIO, U. S. A.

Just a squeeze sets the fastening stud in steel or concrete!

THAT'S HOW SIMPLE IT IS—a flex of the finger—to anchor fixtures securely with the Remington Stud Driver. Off goes the power load, the stud is anchored into steel or concrete—straight as an arrow. No predrilling or outside power source required!

You can set both ¼" and ⅜" diameter studs with the Remington Stud Driver—up to 6 studs per minute either size. There are 40 different styles and lengths of Remington Studs to choose from. With this *one* tool, you can take on *every* stud-fastening job—light, medium and heavy-duty—and save time and money on every one of them! Get full details by mailing coupon below.

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STUD DRIVER

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Please send me your free booklet which shows how I can speed my job and save with the Remington Stud Driver.

*Name*_____ *Position*_____

*Firm*_____

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New Developments (Contd.)

and a length of 12 feet and is launched from simplified portable launching racks. Asp is equipped with specially instrumented heads from which the observed data are transmitted to earth by tiny high-frequency radio transmitters. It is powered by a new high-performance solid-propellant rocket motor which enables the rocket to attain more than five times the speed of sound within a few seconds of launching.

TRISONIC WIND TUNNEL

The Army Ballistic Missile Agency located at Redstone Arsenal has brought about the installation of additional wind-tunnel facilities there which will be twice the size of the present tunnel.

The new tunnel will be "trisonic" in that wind velocities in the subsonic, transsonic and supersonic ranges will be obtainable. The speed range will be from zero to Mach 5 or 6. It will have a 14- by 14-inch test chamber capable of testing missile models at the various speeds and will also have variable density, which will allow closer simulation of flight conditions.

NEW SURVIVAL GUN

A new lightweight survival gun just standardized for the Air Force weighs only 2 pounds 6 ounces. Two 14-inch barrels, one for Hornet and the other for .22 long ammunition, are detachable and fit into the light plastic stock. The stock also has space for a compass and fishing gear.

The entire assembly is airtight and will float. An ingenious firing-pin arrangement permits the use of both center-fire Hornets and rim-fire .22's. The gun is made by ArmaLite, a subsidiary of the Fairchild Engine and Airplane Corporation.

NAVY'S F5D SKYLANCER

The Navy's new Douglas F5D Skylancer, an all-weather, supersonic, carrier-based jet fighter which features thin, bat-shaped wings and slender fuselage is designed for catapult take-off from carriers and rapid climb to high altitudes to intercept and destroy the swiftest enemy aircraft. The Skylancer exceeded the speed of sound on its maiden flight. It can be utilized as a general day fighter and an all-weather interceptor as well as a fixed-point interceptor.

HIGH-SPEED TRANSPORT

The fastest U. S. Air Force transport in production is claimed to be the Lockheed 60-ton propjet Hercules C-130 with a top speed of over 370 miles an hour. More than 100 miles an hour faster than presently operating tactical transports, the C-130 can outfly fast passenger airliners while lifting up to 20 tons of cargo. On combat missions with 25,800 pounds of cargo and more than 5,000 gallons of

Northrop Anaheim can

close the loop

in your weapon systems with

GROUND SUPPORT EQUIPMENT,

TRAINING AIDS,

and TECHNICAL MANUALS

Northrop Aircraft and its subsidiary, Radioplane Company, have a backlog of many years experience in guided missile and jet aircraft development. Major engineering and production activities have included such projects as the Snark SM-62 intercontinental missile and the Scorpion F-89 all-weather interceptor.

For these projects, Northrop has designed, developed and produced ground handling equipment; electrical and electronic test equipment and related special tools; mobile training units; and simulators for many major weapon systems. Supporting facilities in these latter fields include systems engineering, reliability analysis, design, prototype development, production, field service, and preparation of technical manuals.

Now, through the Northrop Anaheim Division, the company's capabilities in these supporting activities are available to you to "close the loop" in your weapon systems program. Your inquiry is invited.

For immediate consultation on your problems, contact Mr. Thomas H. Quayle, Division Manager, Northrop Anaheim, 500 East Orangethorpe Ave., Anaheim, Calif.

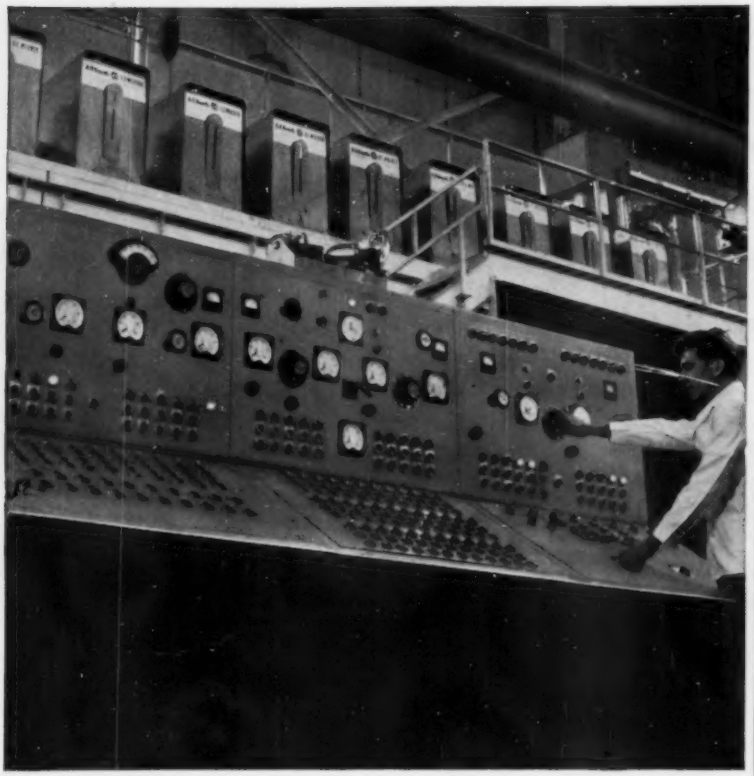
NORTHROP ANAHEIM

Specialists in weapon systems support, opto-mechanical fire control systems, and armament propulsion and explosive mechanisms.

NA-3-56 **A DIVISION OF NORTHROP AIRCRAFT, INC.**

MALLORY·SHARON reports on

TITANIUM



More TITANIUM CAPACITY

... more on the way!

• With the turn of a dial, the first new titanium melting furnace in Mallory-Sharon's current expansion program goes into operation. Like its predecessors, it is remotely controlled from a master panel, with actual melting operations conducted in heavy vaults.

Meanwhile, construction of several additional, larger furnaces is underway. The result will be a tripling of our capacity by January, 1957. All these facilities are based on "Method S"—the consumable electrode double melting process which Mallory-Sharon introduced—and which is now the standard of the industry.

Titanium's strength, lightness, and corrosion resistance have built a demand that's unprecedented for a new metal. Mallory-Sharon intends to meet the need with mill products of the highest quality.

MALLORY-SHARON TITANIUM CORPORATION, NILES, OHIO

MALLORY Ti SHARON

New Developments (Contd.)

fuel, the propjet air carrier can cross the continent, or an ocean, nonstop, cruising at 330 miles an hour.

The transport can take off and climb to 2,500 feet altitude in 60 seconds. Altitude range is up to 40,000 feet—comparable with that of the B-47 strategic jet bomber. The Hercules, however, also operates with high efficiency at 20,000-foot altitudes. In addition, it can fly well at low altitudes and speeds for air drops of personnel and equipment. The C-130 is powered by four Allison T-56 gas-turbine engines driving 15-foot 3-bladed propellers. Cargo and crew compartments are completely pressurized and air-conditioned.

AIRBORNE CONTROL TOWER

A highly mobile 2-man airport control tower that can be transported by helicopter to forward airstrips and put into

Helicopter transports control tower.

operation within thirty minutes has been developed and manufactured by Craig Systems, Inc., Danvers, Mass.

Extremely compact and designed with emphasis on safety and utility so as to reduce operator fatigue, the control set contains all the electronic equipment necessary to operate an airport. Major components include UHF and VHF receivers and transmitters, HF receiver, LF receiver, operators' console, radio, and telephone control panels, wind indicator, altimeters, and such miscellaneous equipment as signal light, binocular, and clocks.

The unit is entirely self-contained except for an electrical power source. Self-supporting masts, antennas, and wind indicator, which are stored inside the unit during transit, are of the quick-assembly type and attach directly to the sides of the shelter.

RADAR MAPPING

A new and rapid means of preparing maps by using radar, developed by scientists at the Army's Signal Corps Laboratories at Fort Monmouth, N. J., will help quickly restore communications in a disaster area. (*Continued on p. 280*)

Air Force "Super-Snooper" SEES ALL . . . TELLS ALL

Reconnaissance television moves GHQ directly over any target zone

Today, the United States Air Force has perfected a far-seeing "third eye"... strategic airborne television. Now the Military Command can watch the TV screen as though it were a living, moving map... and direct distant maneuvers and operations. Philco is proud to have developed a special airborne TV system, to meet the high technical and performance standards of the U.S. Air Force.

PHILCO is Currently Engaged in Long Range Industrial and Diverse Military Engineering Fields

• Guided Missiles • Radar • TRANSAC Digital Computers • Underwater Ordnance • Bombing and Fire Control Systems • Servo-Mechanisms • Microwave Communication Systems • Infra-Red Devices • Transistor Circuit Application • Multiplex Equipment • Television Relay Systems • Industrial TV • Color Broadcast Equipment • Forward Scatter Communications • Fire Control Systems • REDAP

Philco offers a wealth of career opportunities for qualified engineers

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GOVERNMENT and INDUSTRIAL DIVISION • PHILADELPHIA 44, PENNA.

Bendix

GUIDED MISSILES
offer unusual
job opportunities

The development, engineering and manufacture of guided missiles offer many interesting and challenging problems to technically trained people. Missile engineering is a new, dynamic business with long-term potentials and opportunities for those who get in on the ground floor.

This business of the future, while engaged in developing one of our nation's most important weapons systems, has many long-range commercial applications.

We, at Bendix Products Division—Missiles, are fortunate that, as prime contractor, we have the complete responsibility for one of the most important and successful missiles in the country.

A thirty-six-page book, "Your Future in Guided Missiles", describing in detail the many phases of our guided missile operation and the job opportunities available to you, will be sent to you on request. Write for your copy today. BENDIX PRODUCTS DIVISION—MISSILES, 405E, Bendix Drive, South Bend, Ind.

ELECTRONIC GUIDANCE
MISSILE SYSTEMS TESTING
STEERING INTELLIGENCE
QUALITY CONTROL
SYSTEMS ANALYSIS
TEST EQUIPMENT DESIGN
PROPULSION & HYDRAULICS
RELIABILITY
MECHANICAL DESIGN
COMPONENT EVALUATION

Prime Contractor for TALOS MISSILE

New Developments (Contd.)

By photographing the "ground clutter," or reflection of hills, trees, and other earth-bound objects which normally interfere with radar spotting of low-flying airplanes, the Signal Corps can prepare "propagation maps" to determine the best sending, receiving, or relay points for television, radio, and telephone communications under changing battle conditions. This can now be accomplished without danger to friendly troops who might otherwise have to reconnoiter enemy territory exposed to hostile fire.

The new radar-photographic technique requires little time and uses readily available military equipment. In the new system, a radar antenna scans the countryside around the proposed transmission point, and a camera photographs the radar screen. Every part of the terrain that reflects on the screen is good reception territory. The photograph is then superimposed on the existing road or contour map, instantiy showing the best relay points.

PAPER TEST PROJECTILE

A new artillery projectile made of paper and water has been developed by the Army in order to provide an inexpensive shell for test firing. Made at present only for the 105-mm. howitzer, the new shell costs about $1.00. This compares with the $10.00 cost of the conventional metal projectile. Its weight and resistance to the expansion of the propellent gases make it possible to test operation of the howitzer's recoil system. The 105-mm. howitzer using this shell may be fired where the range is only a matter of a hundred feet or so, for the muzzle blasts forth only water and bits of paper.

AIRBORNE RADAR BEACON

Usage by operating squadrons of a new radar device that further extends the reach of America's air striking power was announced recently by the U. S. Air Force and the Sperry Gyroscope Company. The new flying aid is a high-powered, airborne radar beacon that enables long-range aircraft of the Strategic Air Command to locate each other and pinpoint the exact position in space of tanker airplanes, regardless of darkness or weather. Other tactical applications of the device for precisely accurate aërial rendezvous and reconnaissance still are unannounced.

In air-to-air operations, the beacon is installed in designated rendezvous aircraft. Other aircraft wishing to "home" on the beacon dispatch interrogating radar pulses to trigger it. In response to the proper interrogation signal, the beacon in the rendezvous aircraft transmits a coded reply. The operator of the interrogating radar is thereby able to identify the beacon-equipped aircraft as well as to determine its exact range and bearing.

To celebrate its first birthday

THE D9 GETS INCREASED HP

—more power for your operation!

320 HP
(FLYWHEEL)

formerly 286 HP

260 HP
(DRAWBAR)

formerly 230 HP

The giant Turbocharged CAT* D9 Tractor, which since its introduction last year has set new performance standards in the field, now packs more power than ever to handle even bigger jobs. Its drawbar capacity has been increased from 230 HP to 260 HP—its flywheel horsepower from 286 to 320!

This increase in power reflects Caterpillar's policy of leadership in action. Combining research with practical field experience, there's constant product improvement to meet your needs for bigger production at lower cost. This policy applies to *every* product in the Caterpillar line—Diesel Engines, Tractors, Motor Graders and Earthmoving Equipment.

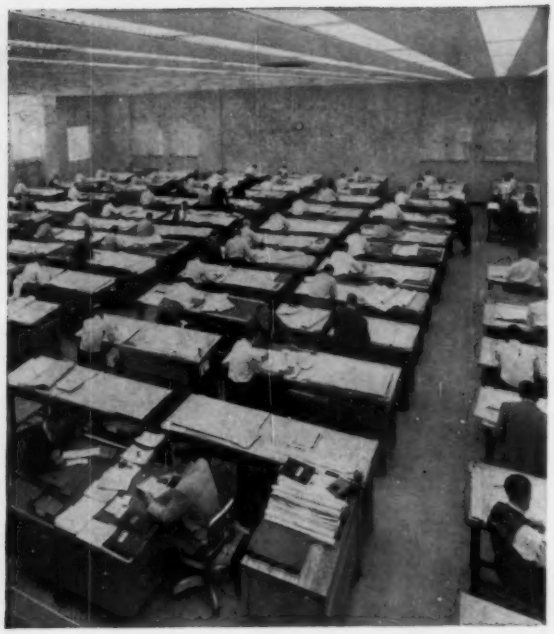
Now, with its increased horsepower, you can give the D9 tougher jobs than ever before. To match your requirements, it's available with torque converter or direct drive with oil clutch. For complete details about the more powerful D9, see your Caterpillar Dealer. Name the date—he'll be glad to demonstrate!

Caterpillar Tractor Co., Peoria, Illinois, U.S.A.

CATERPILLAR*

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

D9—MORE POWERFUL FOR BIGGER PRODUCTION



54 years

OF DESIGNING
AND BUILDING
SPECIAL MACHINERY

● Aetna has been active in Ordnance work continuously through war and peacetime. Our policy is not to build up a heavy load of Ordnance work but to do our share for the country. We want to keep our facilities in trim and our personnel informed and trained so that we will always be ready when needed.

Example of current Ordnance work—the Skysweeper. Production of this weapon has been continuous at the Ellwood City, Pa., plant since 1950.

AETNA • STANDARD

THE AETNA-STANDARD ENGINEERING COMPANY

General Offices: Pittsburgh, Pa. Plants: Ellwood City, Pa., Warren, Ohio

CONTINUOUS GALVANIZING LINES • CONTINUOUS ELECTROLYTIC TINNING LINES SIDE TRIMMING AND SHEAR LINES AND OTHER FINISHING EQUIPMENT • CONTINUOUS BUTT WELD PIPE MILLS • SEAMLESS TUBE MILLS • DRAWBENCHES AND OTHER COLD DRAW EQUIPMENT • ROLLS AND CASTINGS • EXTRUDERS, MILLS, PRESSES FOR RUBBER AND PLASTIC

MATERIALS PROGRESS

George S. Brady

Outlook for Aluminum.—Innumerable "studies" and reports on aluminum have been made in the past few years. Yet, there is no metal right now that is in greater need of a calm, systematic, and impartial appraisal to determine its potentials and its probable position in the next decade.

The Office of Defense Mobilization estimates that the consumption needs for aluminum are now at a rate of 2,300,000 tons annually. But, "consumption needs" is a very relative term and, without detailed explanation, is nearly meaningless. There are latent uses and potential uses which, though small now, could expand suddenly to enormous proportions under conditions of national emergency or under changing commercial pressures.

It is even questionable if we have learned well the lessons of World War II and the Korean campaign in regard to this metal. Previous to World War II, neither aluminum nor its raw material, bauxite, were listed by the military forces as strategic materials. But, at the outset of the war, aluminum was in short supply, and it became one of the three metals on which all metal allocations were based.

Then, in spite of a great expansion in production facilities, the metal remained scarce during the Korean war and was under severe allocation. During that conflict it also became apparent that many of the so-called civilian uses of aluminum were so bound into the essential home economy and that the viewpoint toward "defense-supporting industries" had so broadened that greatly increased quantities of the metal had to be allocated for those purposes.

The high price and unstable market of copper have been quoted by economists as a reason for the rapid developments in aluminum, but it is no more than a minor reason. Copper is, and is likely to remain, a relatively scarce metal, while aluminum is potentially one of the most plentiful metals. Because of its light weight, ease of working, corrosion resistance, attractive appearance, and good electrical properties (aluminum alloys are generally better electrical conductors than the copper brasses and bronzes), aluminum has use possibilities far beyond those of copper.

The demand for aluminum today extends from the gold braid on naval officers' uniforms, which is a nontarnishing colored aluminum yarn, to oil-field piping and bridge girders.

This rapidly broadening field of use has not come about by chance. After World War II the largest aluminum producer, whose operations had been plagued by charges of monopoly under interpretations of the antitrust laws—which charged monopoly merely because of size regardless of the actions of the company—turned the attention of its sales engineers to broadening the market rather than seeking heavy sales in already developed fields, in order to build more stable foundations for the industry when the time came for expanded production.

Newer producers in the field followed on this idea, and in the intervening decade the broadening of the aluminum market has been one of the most remarkable feats in metals history.

Aluminum in Automobiles.—At the start of the Korean war in 1950 the use of aluminum in automobiles was only fourteen pounds per car. This year it averages thirty-six pounds per car. The incorporation of already-developed aluminum radiators will raise this figure. *Aluminum Company of America* has now also developed a forged disk aluminum wheel for tubeless truck tires

(*Continued on p. 285*)

Here's a sound thought! Clip this ad—keep it handy. That way, you'll know how to reach a convenient Wolverine sales office for information, not only on rotating bands, but for your general tubing needs as well.

MAPPING YOUR NEEDS

As you can see on the map above, Wolverine sales offices are located to give you quick service—a prime source of supply for copper and gilding metal rotating bands.

Because Wolverine can meet the most exacting demands for quality and precision, it is the top choice of ordnance contractors everywhere. Wolverine produces rotating bands in a wide range of sizes: 20mm, 30mm, 40mm, 75mm, 76mm, 90mm and 105mm.

Better write today for a copy of Wolverine's Statement of Scope. You'll find a quick resume of all Wolverine products and facilities. WOLVERINE TUBE, 1499 Central Avenue, Detroit 9, Michigan.

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☆ ARMY

☆ NAVY

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CARAVAN

AXLE ASSEMBLIES

Caravan automotive type trailer undercarriages assure the rugged, trouble-free mobility needed for the service life of your equipment. Soundly engineered for extra factors of safety, ease of fabrication in your plant, Caravan meets **Mil Specs** for all types of 2 and 4 wheel air and ground support equipment. Let United's engineers help tailor your trailer axle design to your load need.

CARAVANS FOR THE ARMED FORCES:

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Search Lights • Hose Units • Compressors
Maintenance Docks, etc.

AND FOR CIVILIAN REQUIREMENTS:

Welding Sets • Pumps • Well Diggers
Compressors • House Trailers • Motor
Generators • Asphalt Mixers, etc.

THE
UNITED
MANUFACTURING
COMPANY

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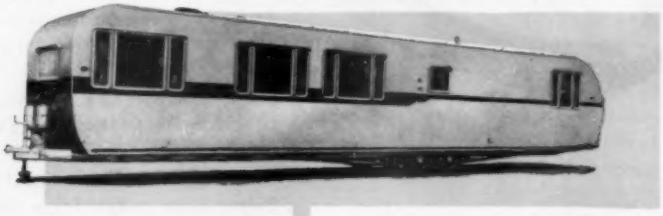
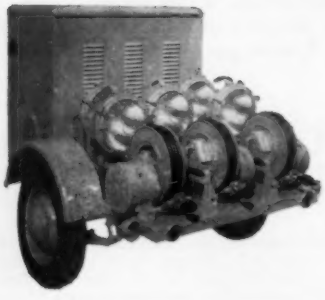
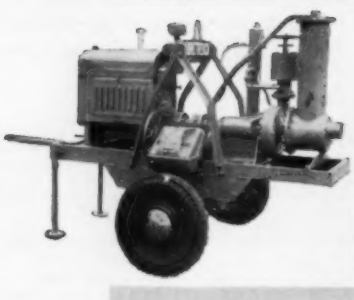
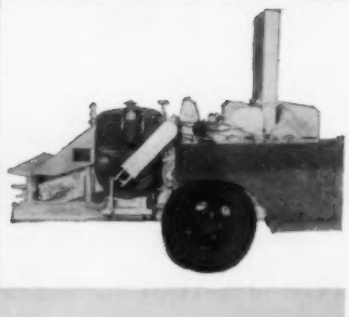








that gives lower unsprung weight, maximum brake drum clearance, easier steering, higher heat conductivity, and smoother riding.

The material used is alloy 5154, with a tensile strength of 42,000 pounds per square inch, and an elongation of 13 per cent in the H34 temper. Added thickness in the rim prevents air loss from denting, and this thicker rim section is machined to insure perfect seats for the tire beads.

Foil Production.—From a relatively small prewar volume aluminum foil production has now reached nearly 100,000 tons annually. The foil used for household food wrapping is only one segment of this market. It is also used for wrapping tobacco, chocolate, cosmetics, cheese, and confectionery.

Heavier foil used by processors for semirigid containers for ready-cooked and ready-to-cook foods is coming into demand at an unprecedented rate. It would be difficult to cut back this use in a war emergency because of the great savings in labor and shipping. One of the newest uses is for throw-away flower pots for shipping seedlings and plants. One West Coast manufacturer, *Aluminum Packages, Inc.*, states that it produced 15,000,000 of these pots in the first six months of 1956.

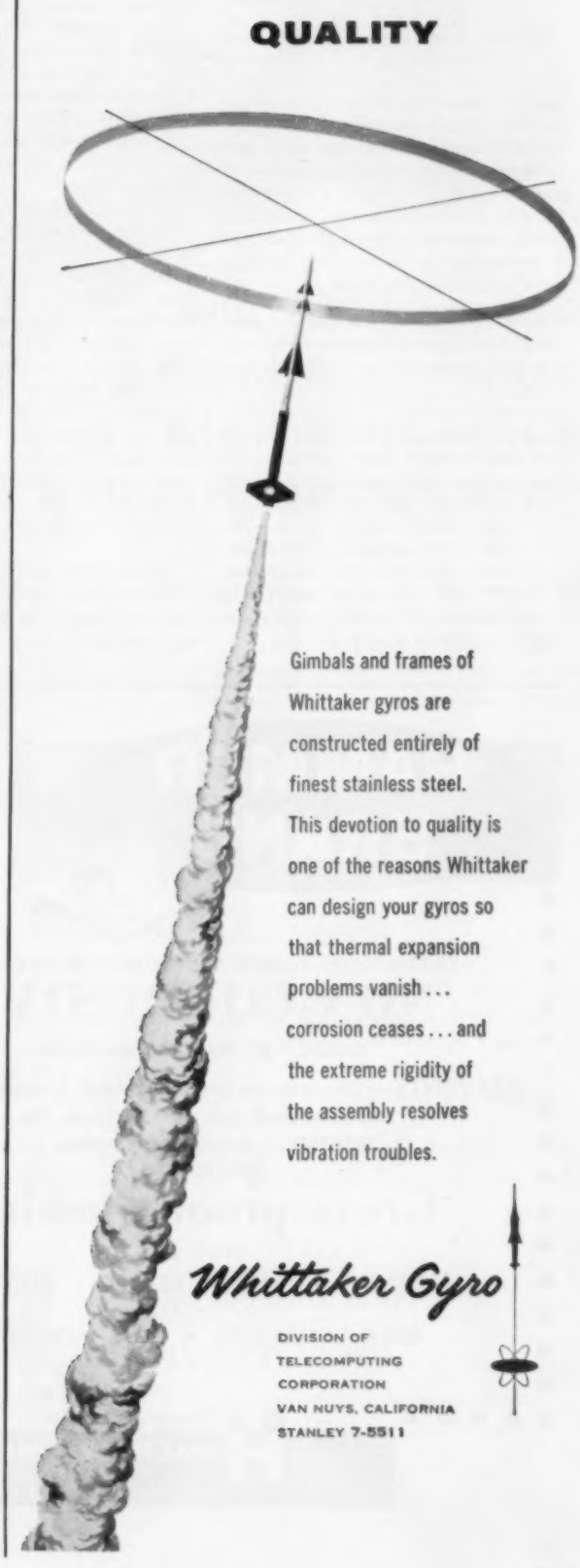
New Destroyer.—A new type of destroyer, Class DD931, now being built at the Quincy, Mass., yard of the *Bethlehem Steel Company*, has the entire superstructure and much of the interior work of aluminum. It not only saves weight but lowers the center of gravity and keeps these small fast vessels from being top-heavy. The superstructure is Kaiser alloy 5083, and the deck housings, ladders, and piping are of alloy 6061-T6. The air ducts are of alloy 5052-H32 and 5052-H34, and the lockers are of alloy 5052-H32 sheet.

Large Extrusions.—An unprecedented demand for large, high-strength aluminum alloy extrusions, most of which are for aircraft and missile structural parts, had led *Aluminum Company of America* to order another 14,000-ton extrusion press for its Lafayette, Ind., works, to be in operation early in 1959. The press already installed produces ribbed wing sections, wing spars, helicopter rotor blades, and other parts weighing as much as 2,500 pounds, all in one piece, making possible drastic reductions in airplane weight and reductions in assembly costs.

Aluminum Dry Cell.—Soon to be on the market is a new aluminum dry cell battery developed by the *Aluminum Company of America*. It is interchangeable with zinc batteries and has a longer shelf life. The battery has a potential of 1.6 to 1.7 volts per cell. This company has also developed a new aluminum casting alloy that has high tensile and yield strengths at temperatures to 600 degrees Fahrenheit, and is suitable for use in aircraft engines and gas turbines. The alloy, known as XA140, contains 8 per cent copper, 6 magnesium, 0.5 nickel, 0.5 manganese, small quantities of boron and titanium to refine the grain, and some beryllium for oxidation resistance.

Lightweight Pipe.—Installation comparisons made by the *Reynolds Metals Company* in the Texas oil fields on a 6-mile length of 2⅞-inch pipe showed that the whole job of laying aluminum pipe required 9 hours of labor and 3 hours of truck time while a comparable job with steel pipe took 98 hours of labor and 6 hours of truck time. Aluminum pipe has been gaining for petroleum installations because of shipping and handling advantages as well as corrosion resistance.

New Magnet Material.—The *Air Force Research and Development Command* is working with the *Westinghouse Electric Corporation* on a new magnet material which has high coercive force and unusual resistance to demagnetization. The material is a manganese-bismuth compound made by grinding together pure manganese and bismuth powders in an inert atmosphere and then heating to 520 degrees Fahrenheit in a sealed glass vessel. The compound is then reground to a fine powder, imbedded in a


QUALITY
Gimbals and frames of Whittaker gyros are constructed entirely of finest stainless steel. This devotion to quality is one of the reasons Whittaker can design your gyros so that thermal expansion problems vanish . . . corrosion ceases . . . and the extreme rigidity of the assembly resolves vibration troubles.
Whittaker Gyro
DIVISION OF TELECOMPUTING CORPORATION
VAN NUYS, CALIFORNIA
STANLEY 7-5511

Materials Progress (Contd.)

plastic matrix, oriented in a strong magnetic field, and molded to any desired shape.

Tantalum Capacitor.—A new tantalum capacitor developed by the *Bell Laboratories* has higher capacitance per unit of volume than former capacitors, has very long shelf life, and is solid, containing no liquid. It will operate at temperature extremes. Tantalum powder is sintered into a highly porous slug and coated with a thin dielectric film of tantalum dioxide. Manganese dioxide replaces the liquid electrode and is sandwiched in between the tantalum oxide and a lead alloy anode.

Paste Pigment.—A new type of paste pigment for paints and calking compounds is now in production at the pilot plant of *Chemical Sealers, Inc.*, Belleville, Ill. Besides the nonmetallic and mineral colors, the group comprises also copper, bronze, and other metallic flake pigments. The patent on the pastes designates a chlorinated polyphenyl type of wetting agent that gives unusual qualities to the pigment. The paste is nonoxidizing and nonhygroscopic, capable of long storage, and it is compatible with many lacquers and plastic vehicles with which ordinary pigments are difficult to mix.

New Casting Method.—A new method for the economical casting of small precision parts of high-temperature alloys has been developed by the *Corning Glass Works*, Corning, N. Y. The method, called the Glascast disposable-pattern process, uses a wax pattern which is dipped in a powdered glass slurry. The powder is 325 mesh, and the slurry is prepared by mixing with water with a binding agent added. This first dip is dried in ammonia for three minutes.

The pattern is then redipped and the wet surface is coated with coarser grains. It is then dipped five or six times until a mold shell of ⅛- to ¼-inch is built up. The mold is then fired, eliminating the wax pattern at the same time. This one-piece mold will withstand temperatures to 3,300 degrees Fahrenheit.

Castings produced in the molds have tolerances of plus or minus 0.005-inch, and the castings are blemish-free with good finish. The contraction of the cast metal on cooling causes the ceramic mold to crack off, and none of the ceramic adheres to the casting.

Titanium Shutter.—The shutter of the new Rapidyne high-speed aërial camera, capable of speeds up to a five-thousandth of a second, is being made of commercially pure titanium metal. The shutter has one set of leaves, 3½ inches in diameter, which opens and, as it reaches the end of its arc, activates a triggered second set, already open, which snaps shut. The metal requirements were lightness, rigidity, corrosion resistance, strength, resistance to high impact, and susceptibility to high-precision manufacture. The *Hamilton Watch Company* produces the sheet titanium to a thickness of 0.0022-inch with a tolerance of plus or minus 0.001-inch on a special high-precision cold-rolling mill.

Metal Strips for Turbine Blades.—Airfoil shapes for jet engine compressor stator blades and for turbine blades are now available from the *Metals & Controls Corporation*, Attleboro, Mass., as metal strip made by quantity production precision rolling. The strip can be had in stainless steel, Ascoloy, carbon steel, titanium, or in brass or aluminum. It comes in continuous rolls, random lengths, or in straight lengths to six feet, with any desired contour. The thickness may be up to 0.300-inch with widths to 2½ inches. The minimum thickness of the trailing edge is 0.010-inch, which is on a radius or blunt with rounded edges. Guaranteed close tolerances are held on thickness, width, and contour shape.

Magnesium Motor Parts.—The *Redmond Company*, Owosso, Mich., is now using die-cast magnesium stators and end frames in two lines of its fractional-horsepower AC motors. Besides savings in motor weights, advantages claimed are that the parts can be machined rapidly to smoother finishes and closer tolerances.

Magnesium Wheel.—A new lightweight magnesium wheel for tubeless tires which has been tested on experimental cars has been designed by *General Motors Corporation*. The wheel includes three parts—the wheel, a demountable flange, and the hub cap. The flange is bolted to the wheel. Short radial spokes on the wheel provide ventilating openings to cool the brake. The metal used is magnesium alloy AZ81XA, containing about 7.5 per cent aluminum, 0.7 zinc, and 0.15 manganese.

The ultimate strength is 40,000 pounds per square inch, with elongation of 12 per cent and Brinell hardness of 55 in the T4 solution heat-treated condition. After casting in green sand molds, the parts are machined, polished, buffed, and electroplated in chromium with undercoats of zinc, copper, and nickel.

Germanium Rectifier.—While the experts were saying that it would take years to get silicon and germanium rectifiers into commercial production, industry has gone ahead with their practical development. *Perkin Engineering Corporation*,

HAMMER BRAND
TRADE MARK
REG. U.S. PAT. OFF.

TAILOR-MADE PAPERS for PROTECTIVE PACKAGES

NON-CORROSIVE

GRADE A BARRIER MATERIAL

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Inquiries invited.

"79 years of service"

THE HAMERSLEY MFG. CO. PAPERMAKERS

GARFIELD, NEW JERSEY

Light, rugged, fits any trailer— CLARK Tubular Trailer Axle

with brakes that set a new standard of high efficiency and low maintenance

This husky, lightweight axle has a one-piece tubular center of premium analysis steel, forged by the same process as the widely used Clark tubular Axle Housing. It is designed for practically universal application—in new trailers or for replacement; as a complete axle or as a tube minus wheel assemblies.

- Revolutionary brakes establish new standards for high operating efficiency and low maintenance. No slack adjusters or cam shafts. Brake actuators for air, hydraulic, vacuum or air over oil; all mountable at same location—minimizing inventory requirements.

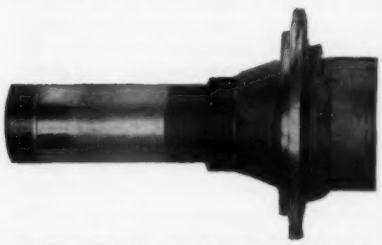
- Two sizes:
  ND 18000—½ inch section, 5-inch OD
  ND 20000—⅝ inch section, 5-inch OD

Standardized spindle dimensions make all wheel and brake parts interchangeable for both sizes, and also interchangeable with axles of other makes. Inventory needs are reduced to a minimum.

Brake linings and shoes can be removed for servicing without disturbing actuators.

As a practical, common-sense step toward more profitable trailer operation, send for the helpful Clark Trailer Axle Bulletin. Use the coupon.

Advanced Brake Design—both shoes are equipped with bell cranks and push rod; and provide Two-Leading Shoe effectiveness for highly efficient braking action in both Forward and Reverse. No stationary pivots—shoes have no fixed location, are free to slide; allowing full lining contact and compensation for wear.



Induction Hardening—For extra strength at a common area of failure, the inner wheel bearing surfaces are induction hardened, increasing the fatigue factor by 400 per cent.

CLARK® EQUIPMENT

CLARK EQUIPMENT COMPANY
Buchanan 12, Michigan

Please send bulletin on Clark Trailer Axle.

NAME_____

COMPANY_____ POSITION_____

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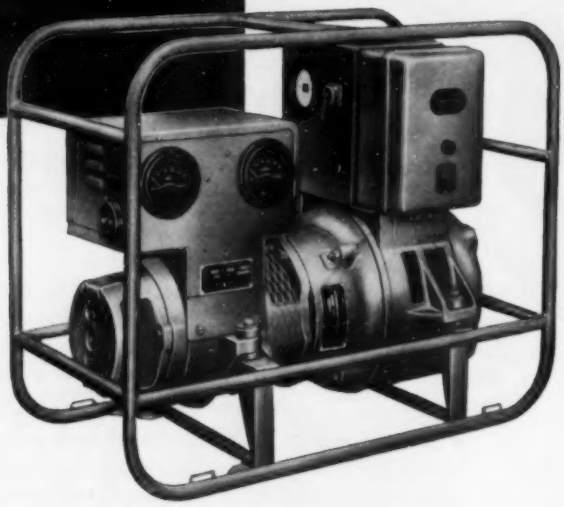
CITY_____ ZONE____ STATE_____

For dependable operation of vital safety equipment

...use this PROVEN Motor Generator



Designed to Military Specifications

This motor generator provides low voltage power as a component of the Air Force Ground Control Approach System. The equipment is compact and light weight with output rating of 2.5 KW, 28 Volts, Direct Current and input rating of 5 HP, 60 Cycles, 3 Phase. The unit is processed to Military Specifications.

Typical of Motoresearch Quality Equipment

The above motor generator is typical of Special Electrical Equipment designed and manufactured by Motoresearch Company. Other specialties include high frequency motors, engine generators, rectifier power supplies and shaded pole induction gearmotors.

Consult with Us

When you need special electrical equipment, send us your specifications and schedule quantity requirements. We will appreciate the opportunity to offer a proposal for your consideration.

MOTORESEARCH COMPANY

1600 JUNCTION AVENUE, RACINE, WISCONSIN

Designers — Gearmotors and Special Electrical Equipment — Manufacturers

Materials Progress (Contd.)

El Segundo, Calif., is now marketing an air-cooled 50-kw germanium rectifier that features efficiency in compact space compared with selenium rectifiers. It can be connected in series or parallel to provide various direct-current voltages. At 400 amperes its d.c. output is 115 to 125 volts. The over-all size of the unit is 52 inches high, 34 inches wide, and 30 inches deep.

Titanium Manufacture.—A new plant of the *Electro Metallurgical Company* at Ashtabula, Ohio, is producing titanium sponge metal by reduction of the liquid titanium chloride with liquid sodium instead of the conventional reduction with magnesium metal. The exothermic reaction in the reactor produces a mixture of titanium sponge and sodium chloride (common salt). This "spalt" is crushed and the water-soluble salt separated by washing and centrifuging. The plant has a capacity of 7,500 tons of titanium sponge annually, more than a third of the total titanium capacity of the country. Easier handling and lower cost are claimed for the process.

Laboratory Crucibles.—Small crucibles for laboratory melting which are made of zirconium boride and are capable of withstanding temperatures to 3,900 degrees Fahrenheit are being made by the *Fisher Scientific Company*, Pittsburgh, Pa. The crucibles can be used for melting high alloys, and they are not attacked by molten aluminum, copper, magnesium, or any ordinary metal.

Synthetic Diamond Production.—Synthetic diamonds are now out of the laboratory stage and are in pilot-plant production at *General Electric*'s carboloy department in Detroit while research is being carried on to reduce production costs. The company expects to be able to make diamonds equal in size to at least eighty per cent of those currently used for industrial purposes. Pressures used in the process are as high as 2,700,000 pounds per square inch, with temperatures as high as 5,000 degrees Fahrenheit.

New Plastic.—A new type of plastic developed in Italy at the *Milan Polytechnic Institute* is based on polypropylene. It is lower in cost than polyethylene plastics and has some outstanding advantages. The plastic has a crystalline structure, giving high strength and high resistance to solvents, and the melting point is as high as 320 degrees Fahrenheit. The material can be used for both moldings and fibers. Fibers have been produced that are higher in strength than those made of nylon. The polymer has an oriented spiral pattern of alternating CH_2 and CHR groups in the molecule. The polymer is isotactic, with the monomer units having the same configuration as the asymmetric carbon atoms.

Hobart Delivers Higher Standards, Lower Cost per Serving— in Kitchen-Wide Installations

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ARMAMENT ELECTRONICS

Dr. W. S. Carlson

IT is evident from the volume of technical literature currently appearing in this country and abroad that an unprecedented effort is being invested in basic and applied research pertaining to solid-state electronics. Understandably, primary emphasis is placed on the transistor. Although early obsolescence of thermionic devices is not in prospect, military and commercial applications of transistors are expanding.

A dial telephone switchboard in which transistors and crystal diodes perform the functions of line finding, switching, and signal-tone generation has been developed by the Navy for shipboard installation.

The Signal Corps has made use of transistors to achieve a drastic reduction in size, weight, and power demand of repeater amplifiers for field telephone service. A video simulator for radar testing has recently been described in which transistor circuits are used for pulse forming, timing, and counting.

Radio receivers and audio amplifiers frequently provide illustrative applications of the duality relationships obtaining between transistor and vacuum-tube circuits serving the same functions. The duality concept is based on the fact that collector characteristics of semiconductor and thermionic triodes are roughly similar if the current axis of the transistor characteristic is taken as the analogue of the voltage axis of the tube characteristic.

Likewise, bias current stabilization in the transistor circuit may be regarded as the equivalent of bias potential in the vacuum-tube circuit. In general, duality obtains as between two networks if a constant current generator in one circuit corresponds to a constant voltage generator in the other—a series impedance corresponds to a parallel admittance.

Employed with due regard for its limitations, the duality concept affords a convenient means for translating many familiar vacuum-tube networks into the transistor equivalents. It should not be supposed, however, that the design of practical transistor circuits is simply a matter of making proper substitutions in vacuum-tube circuits.

Limited frequency response as compared with high perveance thermionic tubes has precluded consideration of the transistor for many important commercial and military applications. Maximum frequency of oscillation depends on the ratio $(fa/r_bC_c)^{1/2}$. Several techniques have been used to improve high-frequency performance. The n-p-n tetrode is a grown junction transistor provided with two contacts on opposite sides of the base (p-region).

A bias potential applied between the base contacts results in a low base resistance (r_b). For high alpha cutoff (f_a) the base region must be thin, and for low collector capacitance (C_c) the cross section area must be small. Devices of this type have been operated as low-power oscillators at frequencies 1,000 mc.

THE p-n-p surface-barrier transistor is made by electrolytically etching a central area of the germanium wafer to a thickness of about 0.0001-inch. Emitter and collector contacts are plated on the base by reversing the etching process. Like the tetrode, the surface-barrier transistor achieves frequency response at the expense of power handling.

The surface-barrier design has, however, proved useful as a high-speed switch in computer applications. Development of the vapor phase diffusion process for forming the base layer has extended (f_a) for germanium to >400 mc with permissible collector dissipation of 150 milliwatts.

In video amplifier service, transistors of this type afford a power gain per stage of $20 \pm \frac{1}{2}$ db over a 20-mc band. Silicon units exhibiting $(f_a) > 100$ mc, with permissible collector dissipation of 500 milliwatts also have been produced.

The relatively high-gain x bandwidth product attainable with diffused junction transistors will undoubtedly lead to applications in connection with missile guidance and airborne video relay.

Progress has also been made in exploitation of junction rectifiers. Crystal detectors, principally lead sulfide and silicon carbide, played an important part in the development of wireless telegraphy and were widely used in early radio broadcast receivers. Thermionic devices displaced the crystal detector before a serviceable theory of its electrical behavior was achieved. Subsequent evolution of electronic art until World War II was based largely on vacuum or gas discharge tubes.

(*Continued on p. 292*)

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Armament Electronics (Contd.)

With the advent of microwave radar, frequency limitations associated with transit time effects and interelectrode capacitances in thermionic tubes necessitated returning to the crystal detector. However, developments in chemistry and metallurgy made it possible to abandon mineral sources in favor of synthetic crystals grown under close process control. In this way satisfactory conversion efficiency and noise figure could consistently be obtained.

The crystal diode as currently produced meets higher standards of uniformity and electrical stability than can be attained with thermionic devices. In addition to microwave mixer service, crystal diodes are used as video detectors, harmonic generators, and voltage references.

For power-conversion applications, germanium and silicon p-n junctions have become available to supplement the older selenium and copper-oxide barrier layer rectifiers. Diffused junction silicon power diodes can be made to pass a current density of 2000 amperes/cm^2. Units rated at 50 amperes, 300 peak inverse volts, 150-degree Centigrade mounting stud temperature are offered commercially. The forward/reverse resistance ratio is of the order 1/100,000. A germanium rectifier installation rated at 1,950 kw has been made in an electrochemicals plant and much larger installations are contemplated in the future.

THE rectifying p-n junction has also been utilized in connection with the photoelectric properties of silicon and germanium. The solar battery, intended as a power converter for operation of rural telephone circuits, is of special interest because its conversion efficiency, about ten per cent, is the highest yet attained with this type of device.

Unit cell of the solar battery is a plate of n-silicon containing arsenic as the donor impurity. The arsenic atom is accommodated in the tetravalent silicon lattice in such a way that relatively little energy is required to ionize the impurity atom and thus to make available a mobile electron for conduction.

When the cell is exposed to sunlight, electron-hole pairs are created by photon absorption. If this occurs in the vicinity of the junction, the electrons are drawn into the n-region and the holes into the p-region. This flow upsets the balance established at thermal equilibrium and gives rise to a current in the external circuit. This current is maintained as long as the cell is exposed to radiation. Response extends from the visible spectrum to about 1.1μ in the infrared. Peak power output is obtained at about 0.3-volt over a wide range of current. This constant voltage generator characteristic makes the cell suited for a storage-battery charging.

● Manufacturing ●● Manufacturing and product development ●●● Manufacturing, product development and research □●● Pilot manufacturing, product development and research

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	GPE CAPACITIES
●●●	●●	●●	□●●	●●	●●●		●●	●●●	●●	●●	●●	●●●	Precision Mechanics, Optical Devices, Ceramics
●●●	●	●			●●●		●●●	●●	●	●●	●	●●●	Electrical Equipment and Components
●●●	●●	●●●	●●●		●●●		●	●●		●●●	●●	●●●	Electronics
	●●			●●●		●●●				●●●			Hydraulics, Liquids Processing, Heat Exchange
●	●		●●●		●					●			Television: Studio, Theatre, Business, Institutional, Industrial
●●●	●	●●	□●●		●●●	●●●	●●	●●		●●●	●	●●●	Instruments, Servos, Controls: Hydraulic, Pneumatic, Magnetic, Electronic
●●●	●		●●●		●●●		●			●●	●	●●●	Aircraft and Missile Guidance, Control, Simulation
●●●	●	●	□●●		●●●					●●●		●●●	Automatic Computers and Components
●●●	●	●●	●●●		●●			●		●			Radar, Microwave, Ultrasonics
	●●●		□●●				●●	●●●	●●●		●●●		Motion Picture and Audio Equipment
●●●				●●						●●		●●●	Nuclear Power Components and Controls
●●●			●●●	●●●	●●●	●●●				●●●		●●●	SYSTEMS ENGINEERING

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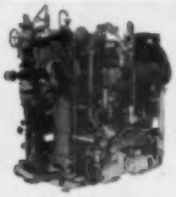
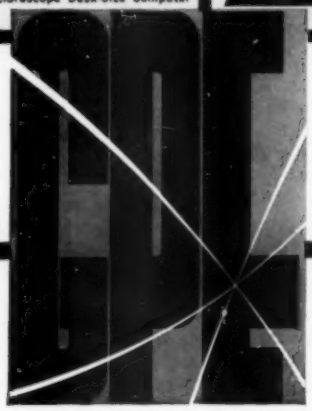


Griscom-Russell Shipboard Distilling Plant

Askania Electro-Jet Power Package



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No GPE company is limited by the boundaries of its own specialties. The basic GPE operating policy, GPE Coordinated Precision Technology, places at the command of each company in the group all GPE research, development and production facilities, and the skills and experience of the more than 2500 GPE technical men working in depth in the wide range of advanced capacities indicated in the chart above.

Behind each group working on a specific problem in one GPE company stands the whole group of GPE scientists, engineers and technicians with the answers — or the knowledge that will find the answers — to questions underlying and related to that problem. To the customers of GPE Companies this means that the concept and development of equipment, components and systems are not restricted or distorted by traditional allegiance to specific competences.

The five systems illustrated, while products of different GPE companies, are all examples of the consistent application of balanced competences, achieved through GPE coordination. For brochure describing GPE Coordinated Precision Technology and the work of the GPE Companies, or help on a specific problem, write: General Precision Equipment Corporation, 92 Gold Street, New York 38, N. Y.

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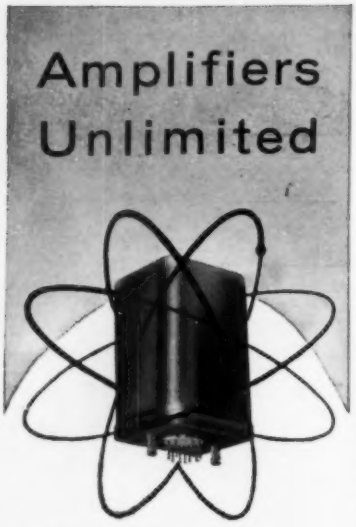

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ROCKETS AND GUIDED MISSILES

Alfred J. Zaehringer

Astronautics.—Design of the *Vanguard* satellite has now been clarified by the Navy Department. The 3-stage rocket will be 72 feet long and will have a maximum diameter of 45 inches. The entire vehicle will gross about 11 tons.

The first stage, a substantially improved Martin *Viking* rocket, will get its power from a General Electric rocket motor burning liquid oxygen and gasoline. Propellant feed will be by turbo pumps. To control orientation and flight path, the motor can be tilted. About 15 per cent of the required orbital velocity (the velocity required by a body orbiting at 300 miles is about 25,000 feet a second) will come from this first-stage booster.

The second rocket, by Aerojet-General, will employ pressure-fed nitric acid and unsymmetrical dimethyl-hydrazine. This rocket motor is also to be gimbal-mounted for control. The brain or master control system for all three stages will be located in this second step. Some thirty-two per cent of the orbital velocity will come from this *Aerobee*-like rocket.

Final choice of a propellant for the third stage has not yet been made. Both Allegany Ballistics Laboratory and Grand Central Rocket Company are presently working on the development of stage three. This stage will be fired when it is parallel to the earth after it has been separated from stage two. Stability will be imparted from spin along the longitudinal axis. The firing will take place at orbital height, and about fifty per cent of the velocity of the satellite will be provided by the final rocket. The satellite itself is now conceived as a 20-inch-diameter sphere.

"Minitrack," a system developed by the Naval Research Laboratory, will keep us posted on the position of the satellite once it is in the orbit. Minitrack is a subminiature radio transmitter which can operate on its batteries continuously for two weeks. Ground stations will monitor the signals. The signals, 10 to 50 milliwatts' power, will run on the VHF band at 108 mc.

A special station is to be established in the West Indies to receive the signals, but radio amateurs will be encouraged to aid in tracking also. The small transmitter, weighing only a few pounds, will be turned on from the ground. Each tracking station will receive two to four readings a day. About six readings will be required to calculate the orbit.

The Navy has also stated that the average person will have a difficult time in seeing the satellite. It will not carry a beacon light nor is it planned to use a searchlight to illuminate the tiny sphere. Visually, the satellite would be similar to a golf ball traveling at the speed of sound at an altitude of 60,000 feet!

If the observer is in the dark, the satellite in the sunlight, and with not too bright a sky background, (shortly after sunset or just before sunrise) it might be possible to see the synthetic moon. However, it would pass from horizon to horizon in a few minutes.

Although visual gain could be accomplished by optical means (such as binoculars), the field of view would be small, and the satellite would pass through it in a matter of seconds. Thus, the radio link will remain the best possibility of contact with the satellite.

Aërodynamics.—Efforts in the field of hypersonics (speeds above Mach 5) are being intensified by the intercontinental ballistic missile program. We will have to know more about the ICBM which will reënter the atmosphere at speeds of Mach 10 to 20. These speeds would correspond to temperatures of five to ten thousand degrees Fahrenheit. Data gathered from hypersonic wind tunnel tests indicate that the solution to the problem might lie in going away from the present conical ogives. The "cannonball" or hemispherical ogive keeps the strong shock waves ahead of the body and places a cushion or boundary layer of cooler air next to the skin.

Other methods of protecting metals from the frictional effects of supersonic (Mach 1-5) and hypersonic flight are also being explored. It has been found that such materials as plastics with lower heat conductivities actually fare better than metals when the temperatures exceed the melting point of metals.

The Thompson Fiberglass Company of Los Angeles, for example, reports that rocket guide vanes made of laminated plastic had a life of over 2 minutes at 4,500 degrees Fahrenheit. It has been reported that a plastic *Atlas* ICBM warhead is soon to receive tunnel tests. Other low-conductivity materials, such as ceramics, are also of promise. Ceramic-coated metals (cermets) have helped give uncooled ramjet engines a hundred per cent increase in life. (*Continued on p. 296*)

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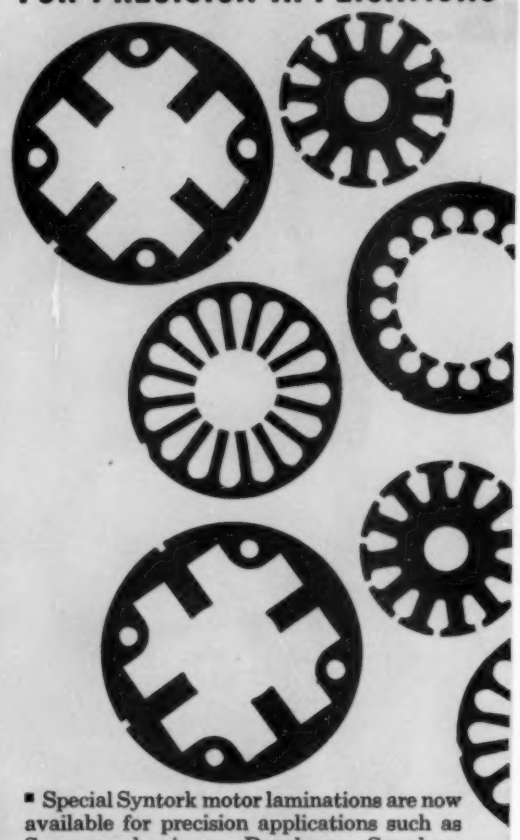

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Rockets and Guided Missiles

Another method of promise is to use porous metals and coolants (sweat cooling). The sweat-cooling method has long been used in rocket engines. At the present time, water appears especially attractive in the transpiration skin cooling of supersonic aircraft and missiles.

Yet another tack might employ surface coatings which sublime. This burn-away technique would be less complex than an internal-external cooling system.

Missiles.—With the advent of the omnipotent intercontinental ballistic missile, serious thought is now being given to an antimissile system. With the possibility that the Soviets may have an ICBM within five to ten years, the Air Force and the Army actually have given contracts which could lead the way to the "antimissile missile." The Army, for example, feels that its *Nike* system could be expanded to this new rôle. There are several serious technical difficulties in developing an effective antimissile system.

An ICBM, for example, would traverse some 5,000 miles in about 30 minutes. A radar would have to pick up the missile far out, accurately plot its course, provide adequate warning to the target area, and launch the intercepting missile.

Propulsion.—Almost all our liquid-propellant rocket systems now employ either liquid oxygen (with alcohol or gasoline) or nitric acid (with amines, etc.). The use of highly concentrated hydrogen peroxide is now largely for auxiliary propulsion (turbo pumps, etc.) although the ROR (rocket on rotor) system for helicopters is an exception.

Little has been made known of such liquid monopropellants as ethylene oxide, isopropyl nitrate, and the nitroparaffins. The advantages of using such potent oxidizers as liquid ozone or fluorine have long been recognized, but much work remains to be done to establish safe handling techniques.

With the steadily increasing performance properties of modern solid propellants it has been estimated that twenty-five to thirty per cent of our high-speed propulsion spectrum will be solids (the remaining will be split almost evenly with liquid rockets and ramjets). Phillips Petroleum Company has revealed its high-performance low-cost solid propellant as consisting of ammonium nitrate (fertilizer), carbon black, and synthetic rubber. In addition, Phillips recently reported that one of its solid-propellant rockets had developed the highest known thrust of any rocket engine. The previous record was the 143,000-pound thrust developed by the German World War II solid booster rocket for the *Rheintochter* antiaircraft missile. Current turbojet engines, for example, deliver up to 20,000-pounds' thrust.

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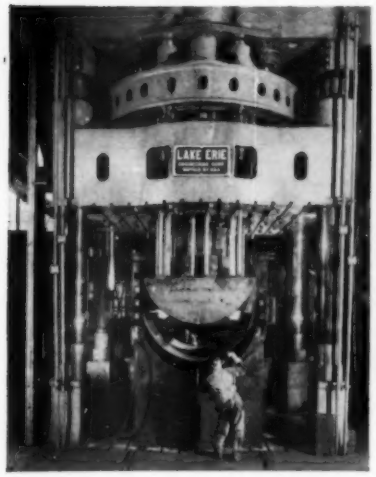

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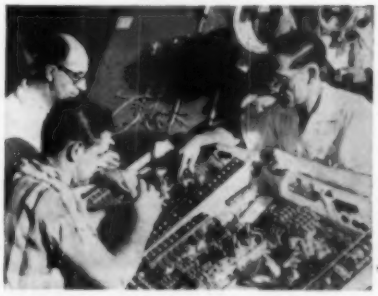

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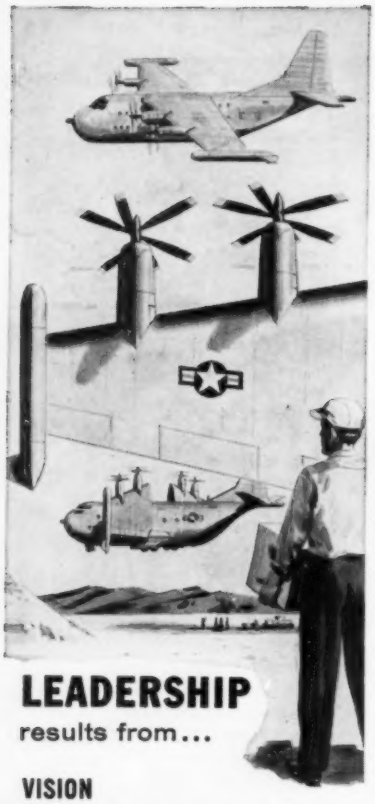
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RECENT PATENTS

This department on recent military-industrial patents is being published in ORDNANCE *to keep our readers informed of the latest developments in these fields. The data are compiled by Melvin Nord, patent attorney, Detroit, Mich. Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each.*—THE EDITORS.

Incendiary Bomb.—*U. S. Patent No. 2,737,114. Issued March 6, 1956, to Emanuel B. Hershberg. Assigned to the Secretary of the Army:* This patent discloses an incendiary bomb which is very effective against residential and industrial targets. On burning, a high internal pressure is created, thus forming jets of flame which have a far-reaching effect outward from the side walls of the bomb, thus starting uncontrollable fires.

A tail on the bomb is automatically separated from the case by means of an explosive charge detonated a predetermined time after impact. This kicks the bomb in the opposite direction with sufficient force to strike against a wall or a piece of furniture where it will come to rest.

In addition, the tailpiece may be provided with an antipersonnel element such as white phosphorus or high explosive equipped with a time delay in order to hinder the work of fire fighters.

Crash-Fire Suppressor.—*U. S. Patent No. 2,737,249. Issued March 6, 1956, to Isadore I. Pinkel et al. Assigned to the Secretary of the Navy:* In order to suppress fires in aircraft after crash landings, a fire protective system automatically cools and blankets heated elements, such as the exhaust tail pipe, with inert gases. The system goes into operation only on excessive craft deceleration and ground contact.

Armor-Piercing Projectile.—*U. S. Patent No. 2,741,180. Issued April 10, 1956, to Leo T. Meister:* This invention improves the penetration of projectiles having shaped charges. When such projectiles are spun at speeds required for flight stability they lose about fifty per cent in the possible depth of their penetration. The present invention provides means for eliminating this spinning of the shaped charge without affecting the rotational speed necessary for flight stability of the projectile.

Variable-Sweepback Wings.—*U. S. Patent No. 2,741,444. Issued April 10, 1956, to Leslie E. Baynes. Assigned to Baynes Aircraft Interiors, Ltd.:* This patent describes a method of varying the sweepback of the wings and the tail loft as the speed of the aircraft changes. The changes produced are as follows: span, 29 feet to 46 feet 6 inches; net wing area, 190 square feet to 238 square feet; net tail area, 61.5 square feet to 72 square feet.

Aircraft Landing Skis.—*U. S. Patent No. 2,741,446. Issued April 10, 1956, to W. John Jakimiuk. Assigned to Société Nationale de Constructions Aéronautiques du Sud-Est:* This invention provides landing skis mounted on aircraft for landing on ice fields or snow-covered grounds. Figures 1 and 2 show how the skis are retracted and lowered. The aperture created in the fuselage when the landing gear is

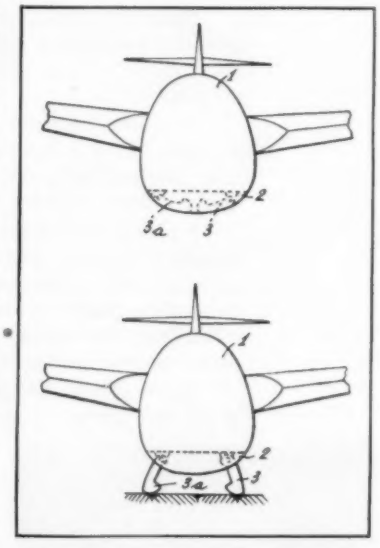

Fig. 1. Skis retracted (top) and lowered.

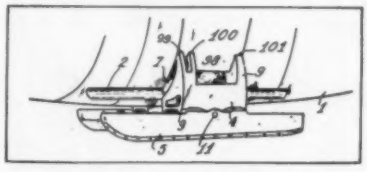

Fig. 2. Detail of retractable ski.

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Recents Patents (Contd.)

lowered is closed by the ski-frame structures themselves.

Variable-Delay Fuze.—*U. S. Patent No. 2,741,182. Issued April 10, 1956, to Charles L. Faust and Leslie D. McGraw. Assigned to the Secretary of the Army:* This invention provides a variable-delay fuze, in which the rate of erosion or decomposition of an anode of an electrolytic cell is used to provide the required predetermined time between arming and initiation of the fuze. A variable resistor determines the flow of current through the cell, and therefore the rate of dissolution of the anode rod. When the rod weakens to the breaking point under the tension of certain springs, the firing pin on the end of the anode rod is driven by its spring into the percussion cap to explode the charge.

Composite Propellants.—*U. S. Patent No. 2,742,672. Issued April 24, 1956, to Charles A. Thomas. Assigned to the Secretary of the Army:* The invention discloses the following process for producing a propellant for jet-actuated devices, as well as several variations in it: (1) intimately mixing finely divided sodium nitrate and finely divided ammonium picrate in a ratio of 1:1; (2) intimately mixing with this mixture a liquid thermosetting synthetic resin (*e.g.*, phenol-formaldehyde); (3) cold molding under pressure; and (4) curing below 80 degrees Centigrade.

Propellants produced in this way burn uniformly without disintegration and are mechanically strong enough to withstand ordinary handling. The temperature sensitivity of the propellant is ten per cent as compared with sixty-four per cent for double-base powders of the cordite type. The propellant described is also less sensitive to conditions of burning, such as the area of the orifice.

Launching Apparatus.—*U. S. Patent No. 2,741,445. Issued August 5, 1956, to Ralph D. Weyerbacher:* This invention provides an apparatus for launching Navy aircraft. It consists of a runway with a continuous cable extending across it in the form of a V-sling. The vertex of the sling is attached to the airplane, and the sling is then forcefully contracted at accelerating towing velocity.

Magnetic Field Regulator.—*U. S. Patent No. 2,735,044. Issued February 14, 1956, to K. G. MacLeish:* This describes an improved electromagnetic regulator capable of providing the accuracy of magnet field regulation necessary in the separation of isotopes. It can maintain the flux between the pole faces of a magnet constant within narrow limits for sudden changes or slow drift.

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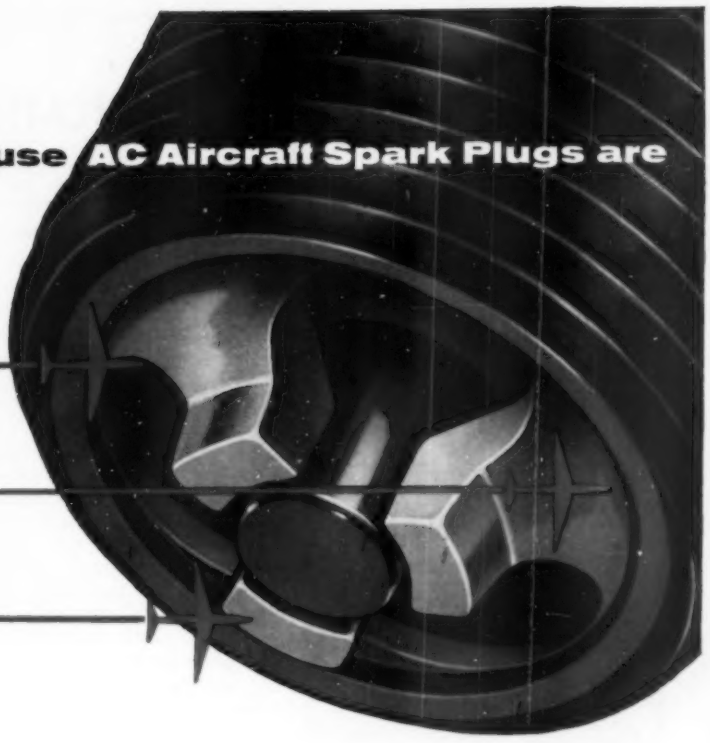

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COMMUNICATIONS

LIGHTWEIGHT HANDGUNS

THE EDITOR.—The article concerning "Lightweight Handguns" in a recent issue of ORDNANCE is, in my opinion, misleading. This article gives the impression that the 9-mm. parabellum cartridge is a very powerful and wholly desirable cartridge. This is simply not so, at least to the extent indicated.

It is an error to state that no revolver is capable of firing the 9-mm. On the contrary, several standard revolver cartridges produce a greater chamber pressure than the 9-mm. Refer to the ballistics of the .357 Smith & Wesson Magnum and the .44 Remington Magnum. It is now possible to have the old Colt single-action revolver rebarreled and rechambered by a custom gunsmith to fire the .30 M1 carbine cartridge which develops a lot more pressure than the 9-mm.

As far as I can see, the main reason that the 9-mm. is not used more generally as a revolver cartridge is because it is extremely unsuited for such use and not because it is too powerful. The modern revolver extraction mechanisms will not function when a rimless-type (9-mm., .45 ACP, etc.) cartridge is fired. This difficulty was overcome during the First World War.

At that time demand for handguns greatly exceeded the supply of Colt automatics. Thereupon, Colt and Smith & Wesson rechambered their current large-caliber revolvers to use the .45 ACP cartridge. The extraction difficulty was overcome by the use of 3-shot half-moon clips which grasped the cartridges at the cannelure.

The major military advantage of the automatic pistol compared with the revolver is its ease and rapidity of loading. Instead of having to insert six cartridges into six little holes one has only to insert a large, easily grasped magazine into the butt of the automatic pistol. This is a very important advantage.

Safety and reliability are the revolver's major asset. Both of these characteristics are the result of the double-action mechanism which Captain Haslam mentions. An automatic pistol with double action will be as reliable and as safe as the revolver. In fact the true measure of safety that the double action affords has never been fully appreciated by pistol designers.

Weight does not enter as a factor into the choice between the .45 ACP and the 9-mm. as a service cartridge. Any pistol capable of shooting the 9-mm. can be barreled to shoot the .45 with little or no

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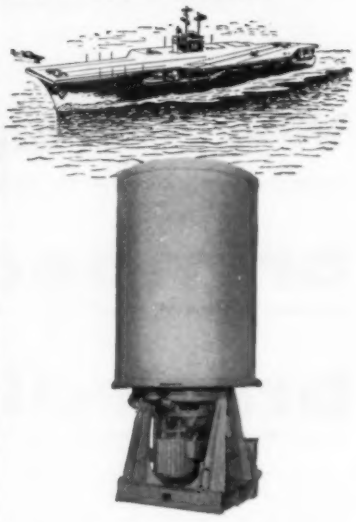

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Communications (Contd.)

gain in weight. The 9-mm.'s parent, the Luger, was tested by the U. S. Army in caliber .45. The Colt Commander model currently available in 9-mm. is also available in caliber .45 at exactly the same weight.

No properly trained person need fear the supposedly heavy recoil of the .45. Besides, a pistol grip designed somewhat better than that of the Colt would eliminate much of the apparent recoil. As in shoulder weapons, a properly designed stock makes sustained fire much easier to endure and control.

The only factors in favor of the 9-mm. over the .45 are smaller diameter and nearly worldwide usage. The smaller diameter makes possible staggered magazines which increase capacity to as many as thirteen shots, as in the 9-mm. Belgian Browning high-power pistol. The use of a universally available cartridge is an advantage from the supply point of view, as enemy and ally ammunition can be used. The British Sten submachine gun (a 9-mm.) was even designed to use the German submachine-gun magazine.

When all is said, the fact still remains that the primary purpose of a pistol is to deliver a fast, close-range shot. Fifteen yards is a better average distance to count on than fifty. At fifteen yards the .45 ACP is a much more efficient man-stopping load than the 9-mm. The stopping power of a bullet is due to other things than the number of pine boards it can penetrate. In fact, penetration is not the primary purpose of a handgun bullet. Practical authorities seem to give the greatest credit to the load which imparts the most energy into the target in the shortest time. The bullet which penetrates the body of the target and dissipates its energy in the background is not an efficient cartridge as far as stopping power is concerned.

If speed alone is such a great advantage, why not adopt a handgun to fire the .30 M1 carbine cartridge? The answer is that the carbine cartridge is inferior in stopping power to the .45 ACP at close ranges. If this is so why turn to the 9-mm. which is inferior to the .30 carbine in speed and energy?

Military cartridges are handicapped by the Geneva Convention which prohibits expanding bullets. Small caliber, high-speed expanding bullets such as can be fired from the 9-mm. are as efficient man-stoppers as the current military loading of the .45 ACP. Unless we are to discard the Geneva Convention as outmoded (a possibility, as certain major powers were not parties to it) we must restrict ourselves to fully jacketed bullets.

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Book REVIEWS

Reviews in this issue by:

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COL. LEO A. CODD, *editor of* ORDNANCE, *Washington, D. C.*

F. W. FOSTER GLEASON, *military historian, ordnance analyst, editor, Washington, D. C.*

MAJ. GEN. E. E. MACMORLAND, *U.S.A. (Ret.), president, Pennsylvania Military College, Chester, Pa.*

COL. CHARLES MCKNIGHT, *U.S.A. (Ret.), ordnance engineer, metallurgist, historian, and former company executive, Fork, Md.*

DR. HARRY C. THOMSON, *chief, Historical Branch, Office of the Chief of Ordnance, United States Army, Washington, D. C.*

BRIG. GEN. THOMAS K. VINCENT, *U.S.A. (Ret.), artillerist, engineer, author, Washington, D. C.*

CAPT. J. M. P. WRIGHT, *U.S.N. (Ret.), naval ordnance engineer, logistician, editor, Washington, D. C.*

Mr. Lincoln's Admirals. By Clarence Edward Macartney. New York: Funk & Wagnalls Company. 335 pp. $5.

IN the long war between the States, the Union Navy would seem to have had a fragmentary part if measured in terms of manpower, great battles, and the number of its leaders. Mr. Lincoln, in fact, had so few admirals in his 55,000-man Navy that the author introduces several captains and the daring Lieutenant Cushing to round out the Navy's story.

However, as our history books point out, the coastal blockade, the seizure of key seaports, and the river campaigns played a vital part in the South's defeat.

The small number of naval leaders in no manner diminishes the significance of their victories. Stories of the achievements of the Admirals Farragut, Porter, Foote, Dahlgren, and Dupont as well as Captains Worden, Winslow, and Collins, and the exploits of Lieutenant Cushing—all experienced seamen—are recorded in many books and histories. Dr. Macartney merely presents his characters in a new light as members of President Lincoln's fighting team in whom he took a close interest.

The author also brings out the strong influence of Gideon Welles, Secretary of the Navy, and his assistant, Gustavus Fox, in all phases of the Union Navy's operations.

Although "Mr. Lincoln's Admirals" is a well-documented historical writing and is a different approach to the record of our Civil War Navy, the style is not sparkling and in the use of the biographical medium the naval actions are not always too clearly associated with the campaigns on land.—J. M. P. WRIGHT.

Eisenhower's Six Great Decisions—Europe 1944-1945. By Lieut. Gen. Walter Bedell Smith. New York: Longmans, Green and Company. 237 pp. $3.95.

GENERAL SMITH is undoubtedly the most authoritative observer to present his opinion of the great decisions which were made by General Eisenhower in the successful campaigns of the

(*Continued on p. 308*)

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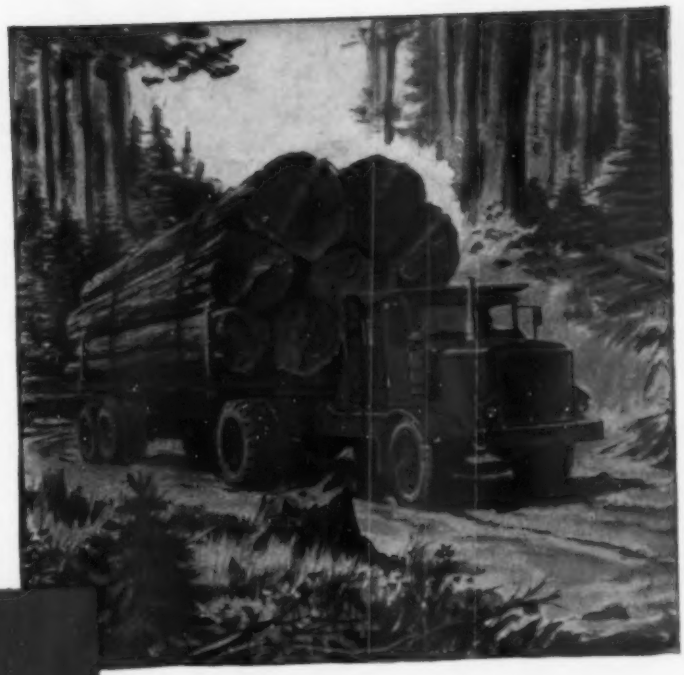

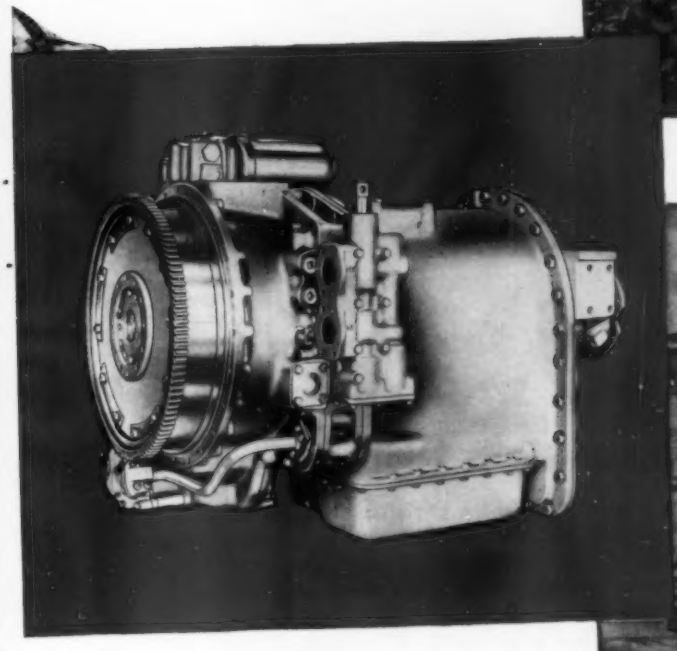

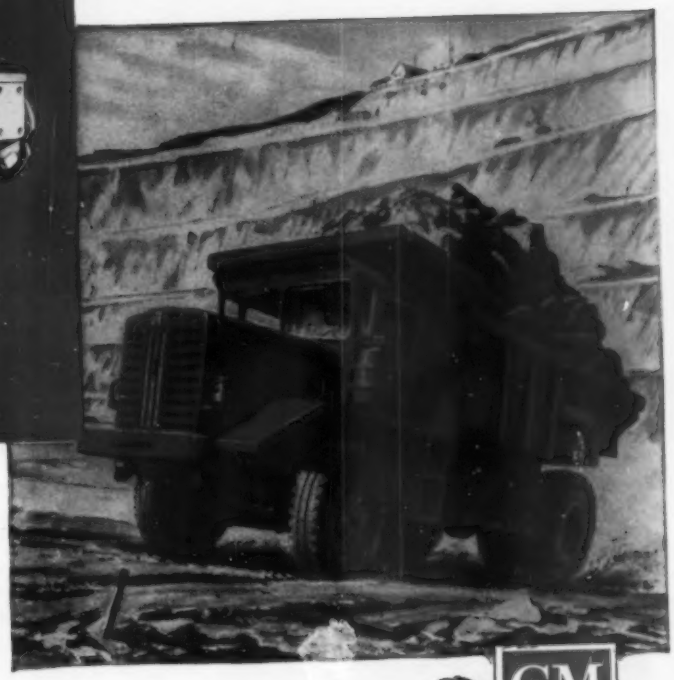

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Book Reviews (Contd.)

Second World War. He was chief of staff to General Eisenhower in that conflict and hence was in a unique position to observe those great strategic decisions that marked the turning points in the war in Europe.

The six great decisions described are: (1) The Invasion Gamble—how and when the D-Day decision was made; (2) Normandy Turning Point—the strategy of the historic break-through; (3) The Battle of the Bulge—the true story of a famous engagement; (4) Victory West of the Rhine—the dispersed offensive and Remagen Bridge; (5) Encirclement of the Ruhr—the pincer movement that baffled the enemy; and (6) The Only Way It Could End—the final defeat of Hitler's armies.

From General Smith's concluding pages this reviewer is convinced that still a seventh decision should have been included in the total; namely, the fatal error of holding the American armies from Berlin and the assignment of that task to the Russians. The disastrous result of that mistake will plague us for decades to come.

The volume at hand is a special edition made available through the kindness of the American Machine & Foundry Company of which General Smith is now vice-chairman of the board of directors. It contains an inscription by Morehead Patterson, chairman of the board of directors, who expressed the belief that this book will be found a superior one. It is in every respect. Its clarity of presentation as well as breadth of view add luster to the record of the author as a brilliant staff officer and administrator.—L. A. Codd.

Global Logistics and Strategy, 1940-1943. By R. M. Leighton and R. W. Coakley. Washington: Government Printing Office. 780 pp. $6.25.

EVER since men first started writing about warfare they have neglected its logistical side. But this hefty tome by two Army historians goes far toward making up for past neglect, and another volume covering 1943-1945 is still to come. From here on in, no one can pretend to speak authoritatively about the logistics of modern war without first reading Leighton and Coakley.

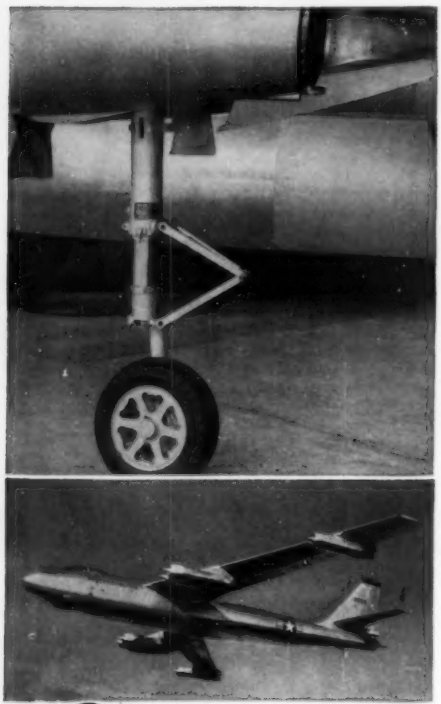
As the title indicates, this book treats strategy and logistics as the warp and woof of military affairs. The interaction of one on the other is always kept in view with the result that the volume gives us a far more complete and meaningful picture of the war than do accounts that focus on battle actions only.

The authors are professional historians who do not hesitate to call a spade a spade and to point out our failures and mistakes as well as our successes. We have had enough bragging about our great logistical achievements in World War II and can now stand some honest searching into our shortcomings. The logistical record in this book does not emerge as a "miracle" but as the result of hard work, careful planning, and learning from mistakes.

Recognizing that logistics is a dull subject, the authors have done their best to avoid writing about it in a dull style. They have made liberal use of colorful quotations such as General Styer's radiogram to General Somervell in Egypt in 1942: "If you want Pentagon Building shipped, please allow more time."—Harry C. Thomson.

The Report on Unidentified Flying Objects. By Edward J. Ruppelt. New York: Doubleday & Company. 315 pp. $4.50.

WITHOUT doubt some of the most controversial matters ever to perplex the public, the scientists, and the military were, or are, the "Flying Saucer" incidents. To a nation, and at least a large part of the world, hopeful that the end of World War II promised an era of relative security, the report of nine very bright, disk-shaped objects flashing across the sky near Mt. Rainier, Wash., marked the beginning of



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a chain of events that is largely an unsolved riddle to this day.

The author upon recall to active Air Force duty in January 1951, found himself in charge of the investigation of unidentified flying objects. He remained in this assignment until August 1953 when he reverted to inactive duty. The results of his tour, with the previous history well integrated as well as later information, are very completely covered in this book.

If the reader of this review has any doubts as to whether he should devote the required time to the "Report," the following percentages summed up therein should decide for an "affirmative": Balloons, 18.51; Aircraft, 11.76; Astronomical bodies, 14.20; Other, 4.21; Hoaxes, 1.66; Insufficient data, 22.72; *Unknowns*, 26.94.—EUGENE A. DUEBER.

Sickles the Incredible. By W. A. Swanberg. New York: Charles Scribner's Sons. 433 pp. $6.

MR. SWANBERG in this brilliant biography describes Daniel Edgar Sickels as a Civil War hero, Congressman tried for murder, close friend of five Presidents, spendthrift and libertine, explosive diplomat, the gaudiest American of his day, and the most spectacularly successful failure of the century. It could be added that he was both immoral and amoral, controversial as well as incredible, possessed of a multitude of friends and a plethora of enemies, a man more evil than good.

It seemed to be the perverse fate of this perverse person that he profit most through guile and suffer from his acts of honesty and sincerity.

But opportunity always beckoned, and in May 1861 Colonel (by virtue of a short hitch in the state militia) Sickles formed the Excelsior Brigade (New York Volunteers) and accomplished the astounding feat of having the troops rationed and fed by Delmonico's (whether Delmonico's was ever reimbursed is not recorded).

Sickles' interest in ordnance and war matériel was demonstrated at about this time. Professor Lowe, the balloonatic of the day, made several ascensions in his balloon, and Sickles was his first and frequent passenger, possibly the first Army officer to make an aërial reconnaissance. Also, due perhaps to his friendship with Lincoln, he interested himself in repeating rifles, sorely needed by the Army, and became a principal stockholder in the Marsh Patent Fire Arms Company. Unfortunately, due to the obstinacy of the then Chief of Ordnance, General Ripley, not one Marsh rifle was delivered.

At Chancellorsville, Sickles, now a major general in command of the III Corps, was at his unpredictable best. Had his battlefield intelligence that Jackson was making a flank march across his front not been ignored at Hooker's headquarters, the outcome of the battle could have been a stunning Union victory. As it was, the III Corps took the brunt of the fighting after Howard's XI Corps was dispelled by Jackson's flank attack and suffered a loss of 4,000 out of 19,000 men. There is little question that Sickles saved the Union Army from ignominious defeat and possible rout.

On July 2, 1863, at the Battle of Gettysburg came the most controversial episode in Sickles' controversial life. He moved his III Corps forward from his assigned position on Cemetery Ridge to form a salient at the Peach Orchard, a scant half mile in advance of the line. Here, late in the afternoon, he met Longstreet's determined attack and here, as the day drew to a close and despite desperate fighting and a flow of reënforcements, his III Corps was forced back to the main line of resistance on Cemetery Ridge whence they had started in the morning. Sickles lost a leg, mangled by a direct cannon ball hit at the height of the fighting, but his Corps lost 4,000 men out of 12,000.

Sickles was technically guilty of disobedience when he advanced his line, and he made a grave mistake (which he de-

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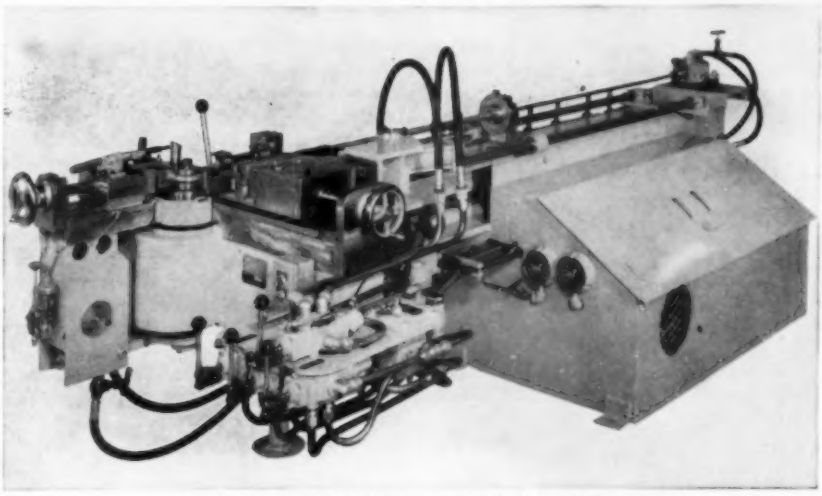

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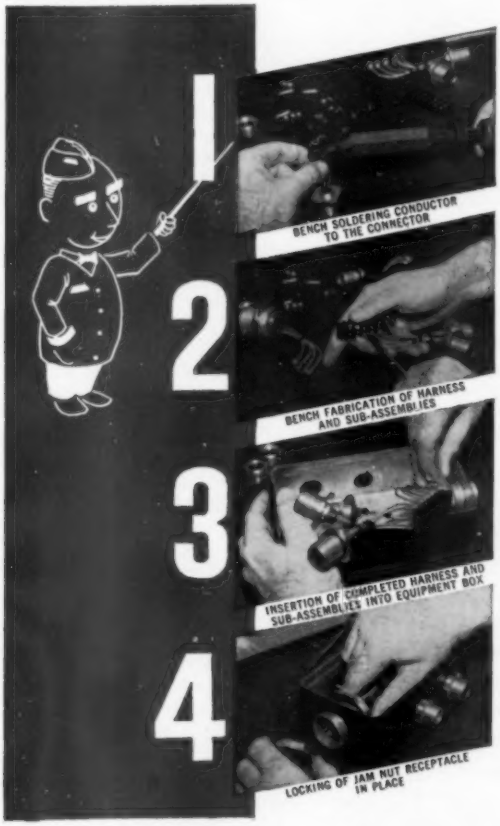
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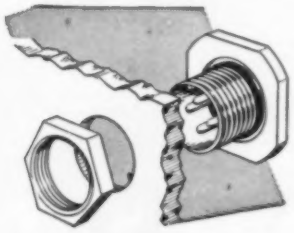

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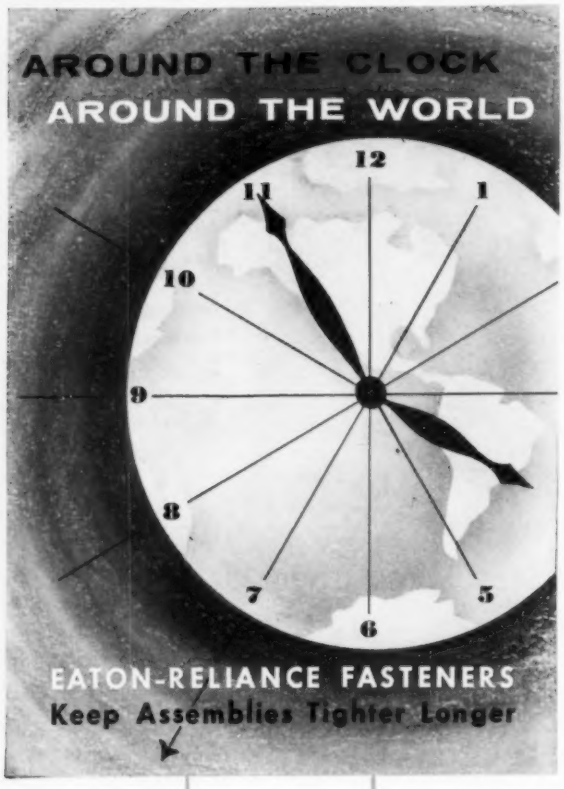

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Book Reviews (Contd.)

nied) in not covering Little Round Top. But had he held the position assigned at the lowest part of Cemetery Ridge (with Little Round Top perhaps not occupied) Longstreet might have broken his line and played havoc in the Union rear.

After the war Sickles was appointed to a diplomatic mission to Panama and Columbia by Lincoln, as Military Governor of South Carolina by President Johnson, and Minister to Spain by President Grant.

General Sickles, U.S.A. (Ret.), finally returned to the U. S. in his sixtieth year and devoted himself to being a professional veteran, a rôle he had been playing since the Civil War. In 1893, in his seventy-fourth year, he got himself elected to Congress with but one purpose, to have the Gettysburg battlefield declared a National Military Park. This accomplished, Gettysburg, protected from commercialism and vandalism, enlarged and developed by the Federal Government, became the world-renowned monument of today.—CHARLES MCKNIGHT.

Gideon Goes to War. By Leonard Mosley. New York: Charles Scribner's Sons. 253 pp. $3.50.

ONE of the most unforgettable figures in World War II was the British officer, Maj. Gen. Orde C. Wingate. Americans who were in the China-Burma-India area will remember him as the strange zealot who was mainly responsible for the Chindit campaign in 1943 against the Japanese in the jungles of Burma.

Wingate was a Scot of strict upbringing and a vast knowledge of the Bible, particularly the Old Testament. As a career army officer, his first important assignment was to Palestine during the period 1936-1939. There he became a devoted advocate of Jewish aspirations for an independent state and a rabid Zionist.

His exploits with the Jewish irregulars were too embarrassing for the Palestine Mandate authorities, and he was transferred back to England—probably just a jump ahead of a court-martial.

Two years later, in 1941, he had made his peace with authority in England and was back in the Middle East where he organized and commanded a miscellaneous force which invaded Italian-held Ethiopia and was largely responsible for the restoration of Haile Selassie to his throne.

His methods in carrying out his mission and his attitude toward his military superiors aroused hostility in the British high command in Cairo so that this brilliant exploit resulted not only in his attempt to take his own life in a fit of depression because of the lack of recognition accorded him, but also in his assignment to an innocuous shelf in England.

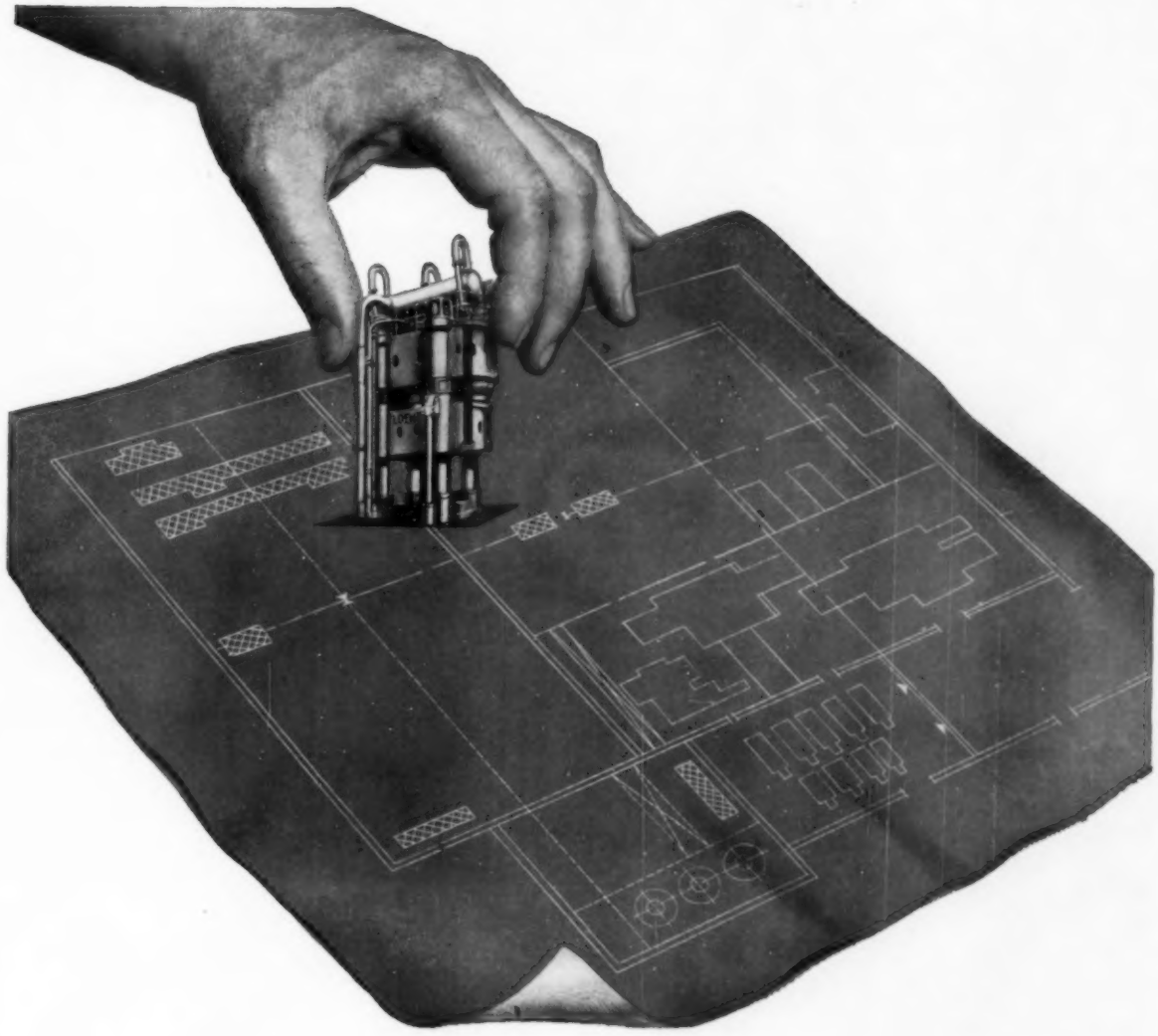
But he bounced back. Churchill displayed an interest in his ideas for long-range penetration, took him to the Quebec Conference where he enlisted the support of our own Gen. "Hap" Arnold, and from these contacts in high places gained approval for a plan whereby the Chindit operation became a fitting prelude for the successful reconquest of Burma. He did not live to see the final outcome. He died in an airplane crash in 1944.

This is a book well worth careful reading by military history students interested in the spectacular career of a man whose whole outlook on military operations was original, imaginative, and unusual.—E. E. MACMORLAND.

The Russian Struggle for Power—1914-1917. By C. Jay Smith, Jr. New York: Philosophical Library. 553 pp. $4.75.

BASED on a doctoral thesis, Professor Smith has produced an accurate, factual narrative of the study of Russian foreign policy during World War I. It is based on diplomatic documents which have been released by the Soviets.

The book has an excellent bibliography and index and is well annotated. It makes the point that Soviet imperialism was a revival of the Tsarist and Russian Provisional Government war aims expressed in 1914-1918.—T. K. VINCENT.



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Decisive Battles of the Civil War. By Lieut. Col. Joseph B. Mitchell. New York: G. P. Putnam's Sons. 226 pp. $4.

SPARKED by Freeman's masterly work, the past two decades have seen very many worth-while approaches to the study and exposition of our great civil conflict. The efforts of these scholars have but indicated the riches yet to be dug from this Golconda of military study. Colonel Mitchell, while utilizing the time-honored and oft-copied framework of Creasy, has added a novel and modern touch of considerable significance and value.

There is hardly the space for detailed study of leaders and movements, yet the condensation is so carefully done that one grasps a satisfactory picture of events. Just enough well-chosen anecdotes are skillfully woven in to give a feeling of intimacy with the scenes and characters. —F. W. FOSTER GLEASON.

BOOKS RECEIVED

Air Force, The. By Arnold Brophy. New York: Gilbert Press Inc. 362 pp. $5.

Aircraft of the World. By William Green and Gerald Pollinger. New York: Hanover House. 211 pp. $7.95.

Airman at Yalta. By Gen. Laurence S. Kutner, U.S.A.F. New York: Duell, Sloan and Pearce. 180 pp. $3.

Atlantic Battle Won, May 1943-May 1945. Vol. X. History of United States Naval Operations in World War II. By Samuel Eliot Morison. Boston: Little, Brown & Company. 399 pp. $6.

Between the Planets, Revised Edition. By Fletcher G. Watson. Cambridge: Harvard University Press. 188 pp. $5.

China's Changing Map. By Theodore Shabad. New York: Frederick A. Praeger. 295 pp. $7.50.

Civilian and the Military, The. By Arthur A. Ekirch, Jr. New York: Oxford University Press. 340 pp. $6.50.

Designed for Digging. By Harold F. Williamson and Kenneth H. Myers, II. Evanston: Northwestern University Press. 384 pp. $7.50.

Eli Whitney and the Birth of American Technology. By Constance McL. Green. Boston: Little, Brown & Company. 215 pp. $3.50.

Electrical Interference. By A. P. Hale. New York: Philosophical Library. 122 pp. $4.75.

Exploration of Mars. By Willy Ley and Wernher von Braun. New York: The Viking Press, Inc. 176 pp. $4.95.

Factory Electrification. By F. T. Bartho and C. H. Pike. New York: Philosophical Library. 398 pp. $12.

French Faust, The—Henri de Saint Simon. By Mathurin Dondo. New York: Philosophical Library. 253 pp. $3.75.

Gentleman and the Tiger, The. Autobiography of George B. McClellan, Jr. Edited by Harold C. Syrett. Philadelphia: J. B. Lippincott Company. 375 pp. $6.

Gray Fox: Robert E. Lee and the Civil War. By Burke Davis. New York: Rinehart & Company. 466 pp. $6.

Government Contracting in Atomic Energy. By Richard A. Tybout. Ann Arbor: University of Michigan Press. 226 pp. $4.50.

Marine Cargo Operations. By Charles L. Sauerbier. New York: John Wiley & Sons, Inc. 548 pp. $10.50.

Mathew Brady—Historian With a Camera. By James D. Horan. New York: Crown Publishers, Inc. 244 pp. $7.50.

200 Miles Up. By J. Gordon Vaeth. New York: The Ronald Press Company. 261 pp. $5.

Military Customs and Traditions. By Maj. Mark M. Boatner, III. New York: David McKay Company. 176 pp. $2.75.

Military Justice in the Armed Forces. By Robinson O. Everett. Harrisburg: Military Service Publishing Company. 338 pp. $5.

Molecular Flow of Gases. By G. N. Patterson. New York: John Wiley & Sons, Inc. 217 pp. $7.50.

Nuclear Fuels. By David H. Gurinsky and George J. Dienes. New York: D. Van Nostrand Company. 364 pp. $7.50.

Officer's Guide, The. Harrisburg: Military Service Publishing Company. 545 pp. $5.

Paratrooper. By Lieut. Col. Francis X. Bradley and Lieut. Col. H. Glen Wood. Harrisburg: Military Service Publishing Company. 80 pp. NP.

Politics of the Prussian Army, The, 1640-1945. By Gordon A. Craig. New York: Oxford University Press. 536 pp. $11.50.

Reactor Shielding Design Manual. Edited by Theodore Rockwell, III. New York: D. Van Nostrand Company. 472 pp. $6.

Robert E. Lee. By Earl Schenck Miers. New York: Alfred Knopf, Inc. 212 pp. $2.50.

Rocket Man. By Lee Correy. New York: Henry Holt & Company. 224 pp. $2.75.

Rockets and Guided Missiles. By John Humphries. New York: The Macmillan Company. 229 pp. $6.

UFO Annual, The. Edited by M. K. Jessup. New York: The Citadel Press. 375 pp. $4.95.

With Beauregard in Mexico. By T. Harry William. Baton Rouge: Louisiana State University Press. 126 pp. $5.

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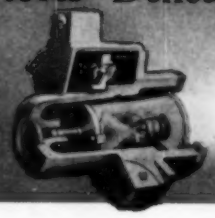

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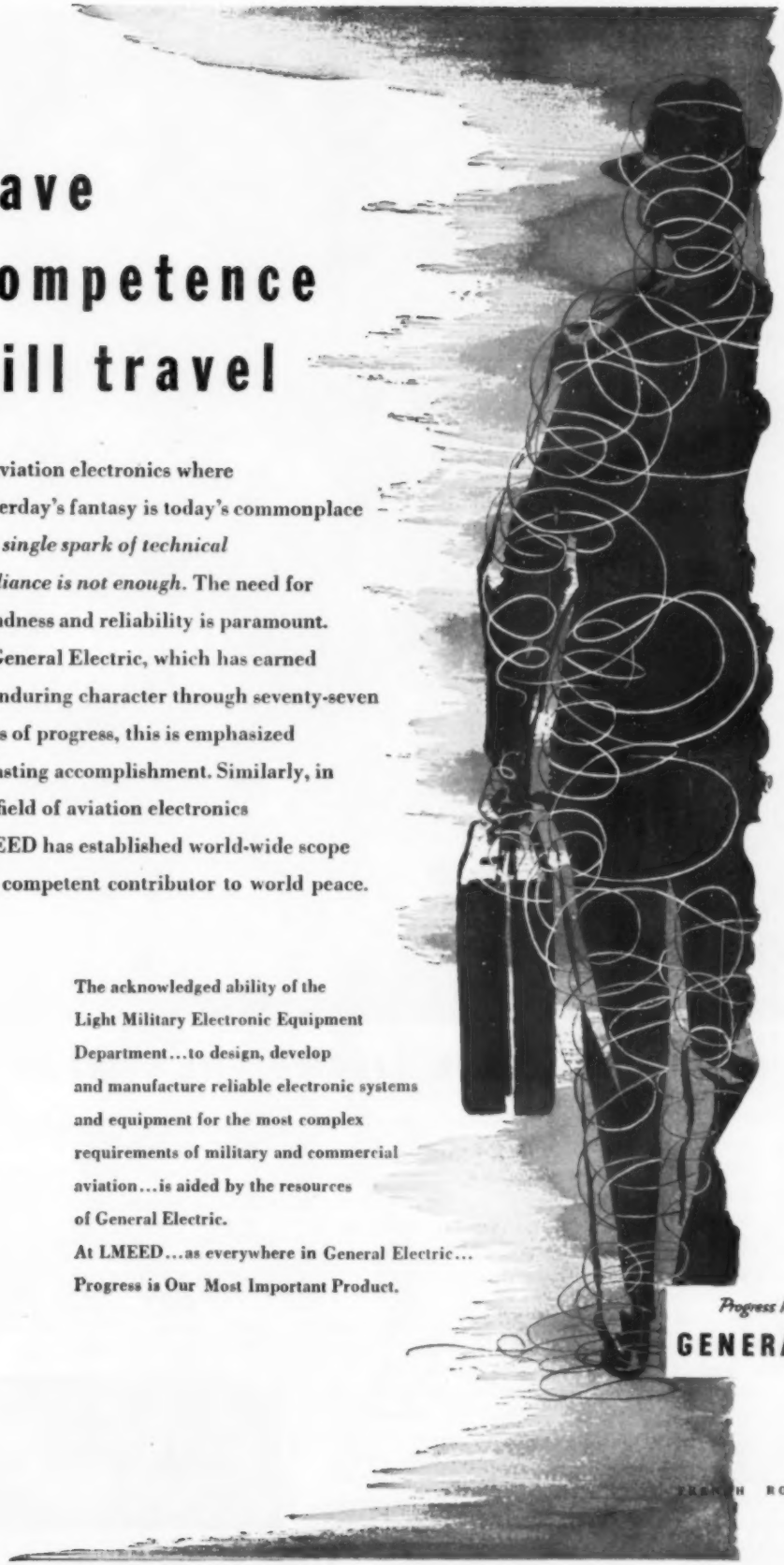

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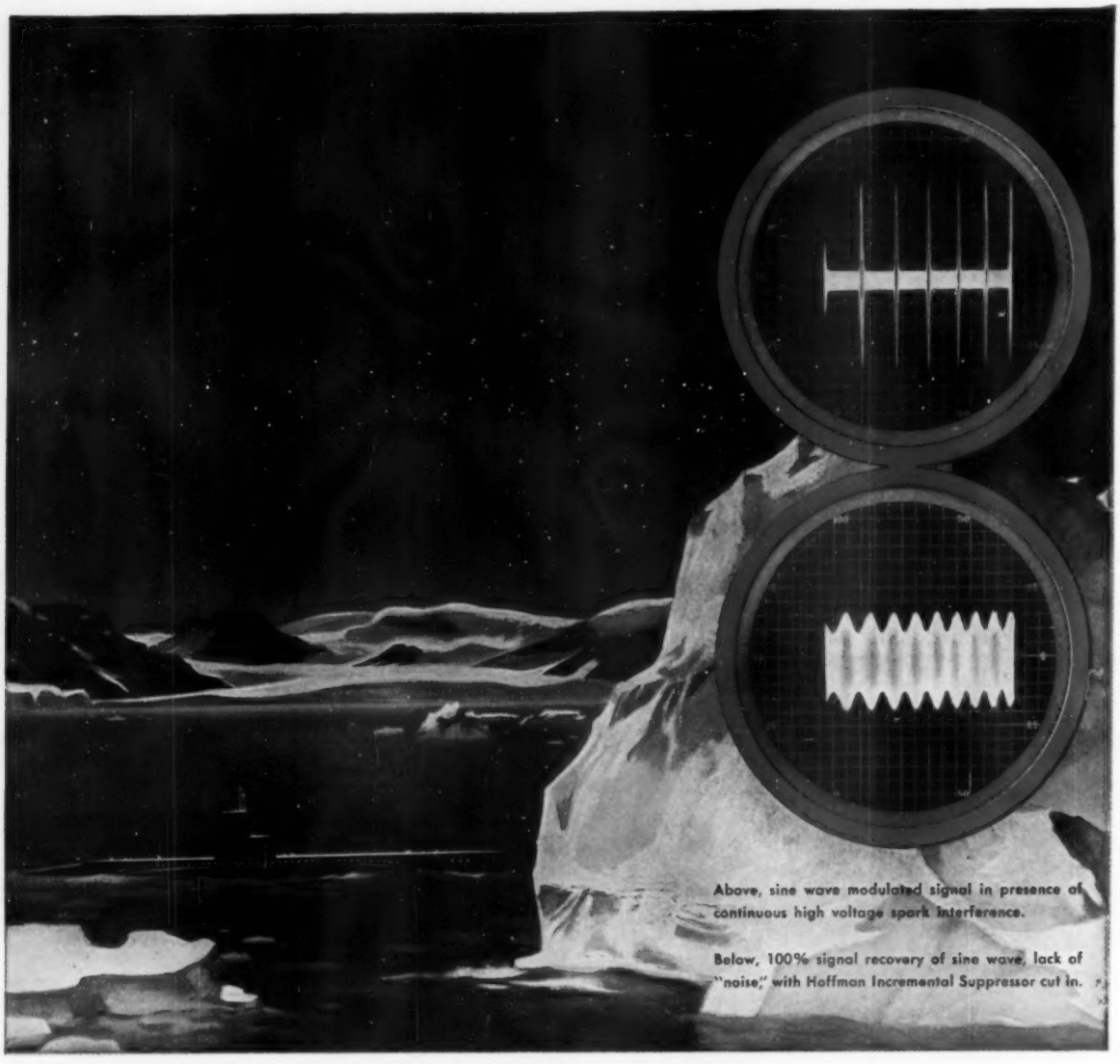
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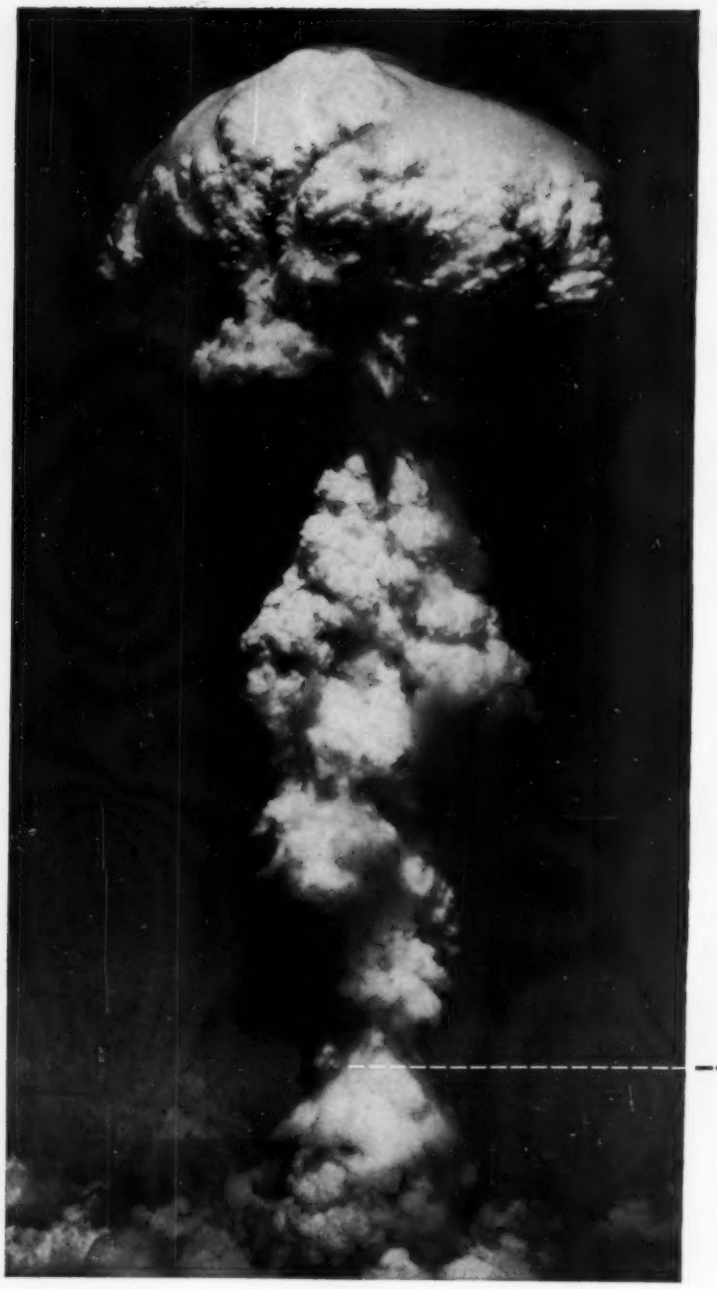

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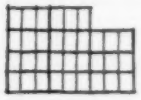
STACK BETTER  **STORE BETTER**

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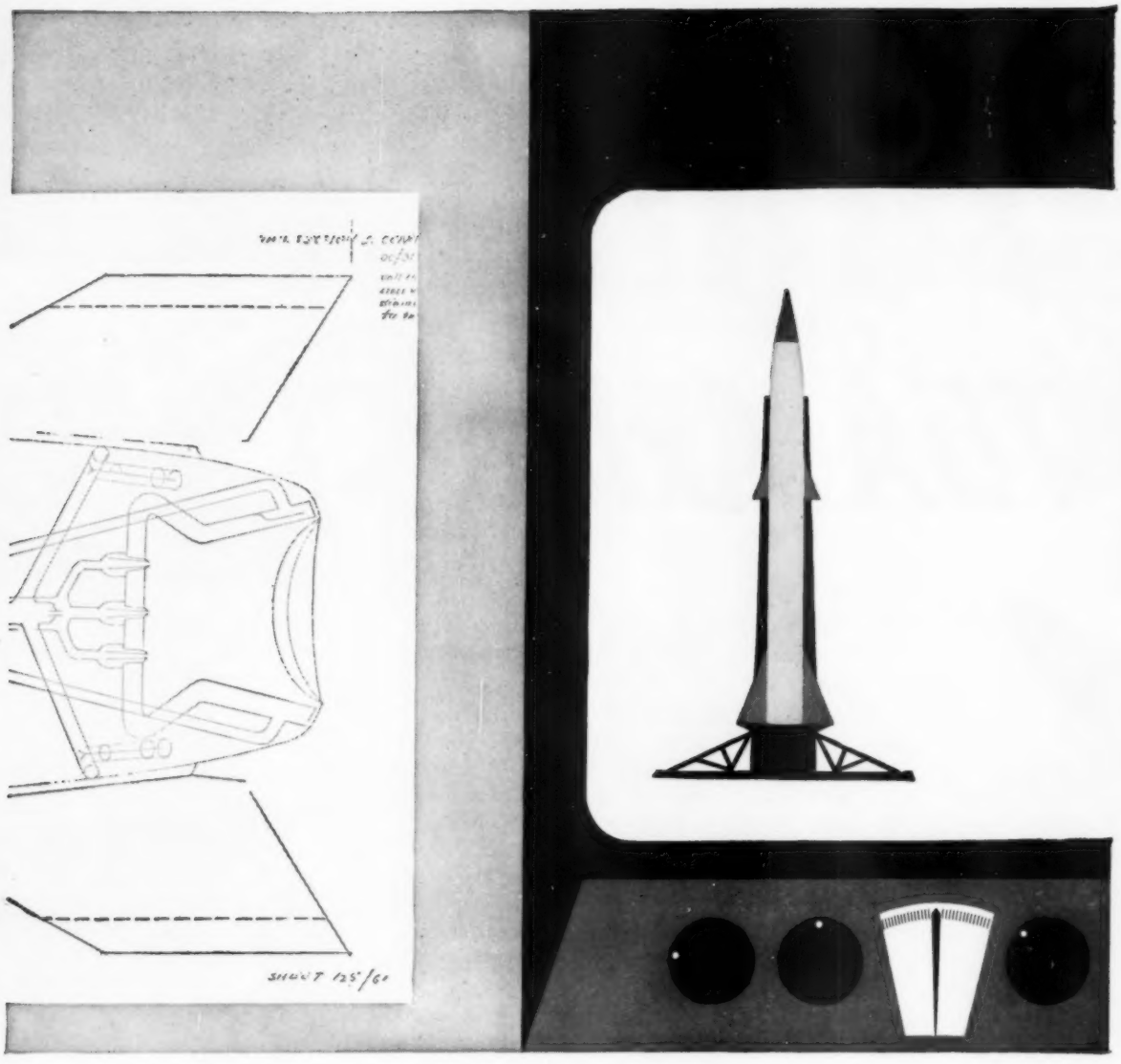

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- *Guided Missile Support Equipment*
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Defense Products Group
AMERICAN MACHINE & FOUNDRY COMPANY
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Air Force Photo

Know your battle station!

Our fighter pilots have a definite defense job, and they know how to handle it. The thousands of other Air Force personnel who "keep 'em flying" are also thoroughly trained in their specific defense duties.

Probably you—and most other citizens—can't fly jet fighters, or even service them, but you can contribute to America's security in many other ways. You should know your rôle *before* an emergency arises.

Your battle station need not be a cockpit. It can be a drafting board, lathe, or desk. It can be any job related to the design, production, or maintenance of ordnance—any support extended to the Science-Industry-Ordnance Team.

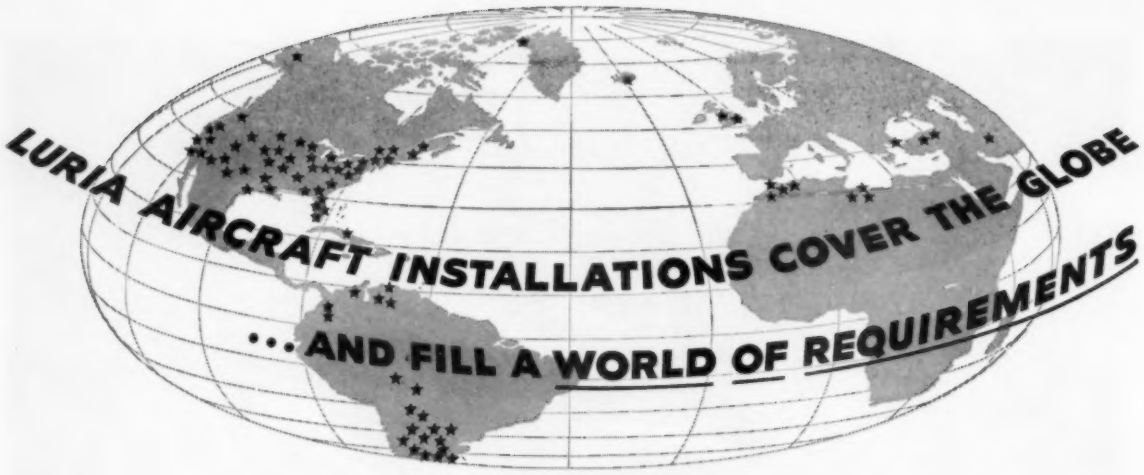
In addition to regular membership services, the American Ordnance Association helps show how you may best fit into the national defense picture.

Members are proud to belong to an Association with this active mission—*Peace through Preparedness.*

AMERICAN ORDNANCE ASSOCIATION

708 Mills Building **Washington 6, D.C.**

Pledged to Scientific and Industrial Preparedness

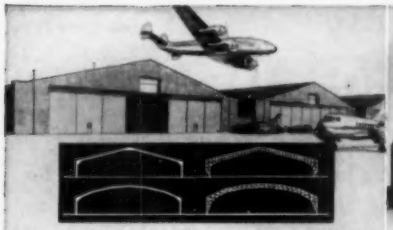


LURIA STANDARDIZATION PROVIDES THE FAST, EASY, ECONOMICAL SOLUTION TO AIRPORT EXPANSION

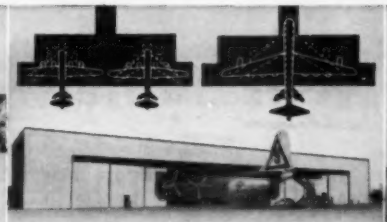
Why do Luria steel structures fill the widest variety of airport needs? Because the Luria System of Standardization provides the *adaptability, flexibility*—yes, and even the *permanence*—that formerly could be found only in *custom-built* units. *And this is achieved without sacrificing the speed and economies of standardization.*

During the last ten years, nearly 500 Luria aircraft installations have been made. The United States Air Force has standardized on 14 Luria designs . . . and uses a wide variety of other Luria hangars. At Lockheed Aircraft, Luria structures cover over a million square feet. Among the hundreds of other Luria installations are hangars and buildings for the airfields of Turkey, Iran and Argentina . . . for many air lines including Pan American, United, American, Eastern, Northwest and Capital . . . and for many airports including New York International, Detroit Wayne Major, Springfield, Illinois and Westchester County, New York.

A PARTIAL SHOWING OF STRUCTURES FOR EVERY TYPE OF MILITARY AND COMMERCIAL AVIATION



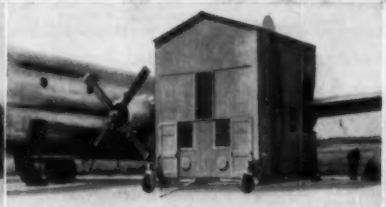
STANDARDIZED HANGARS — both girder and truss types for commercial and military aircraft.



ALL-PURPOSE "WING" HANGAR accommodates one heavy aircraft or two medium aircraft.

DOUBLE CANTILEVER hangar for double-apron air traffic. Accommodates aircraft of all sizes.

AIRPORT TERMINAL shows how effectively Luria steel buildings can be adapted to airport needs.



STANDARDIZED MAINTENANCE SHELTER for heavy aircraft. Portable, enclosed, weather-proof.

- ☑ PERMANENT CONSTRUCTION
- ☑ MAXIMUM FLEXIBILITY
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- ☑ LOW COST MAINTENANCE
- ☑ GREATER AVAILABILITY

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511 Fifth Avenue, New York 17, New York • *Plant:* Bethlehem, Pa. *District Offices:* Atlanta, Philadelphia, Boston, Chicago, Washington, D. C.

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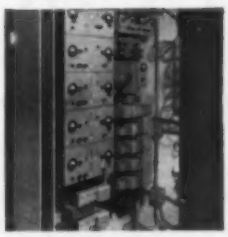
Transportable 900 lb. Magnesium antenna mast telescopes to 100 ft. Trained crew of 8 men can erect mast in less than an hour.

Microwave System capabilities include the transmission of voice communications (up to 72 two-way channels), radar data and radar control functions.



Transportable Packages Grow into Miles of Communications in 2 Hours

A microwave station that can be transported to a site by helicopter and then put into operation in as little as two hours has been developed by Motorola for the U.S. Air Force. The equipment was designed to satisfy Air Force requirements for high information handling capacity, transportability, and quick installation.

Positions open for Engineers and Physicists.

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National Defense Department

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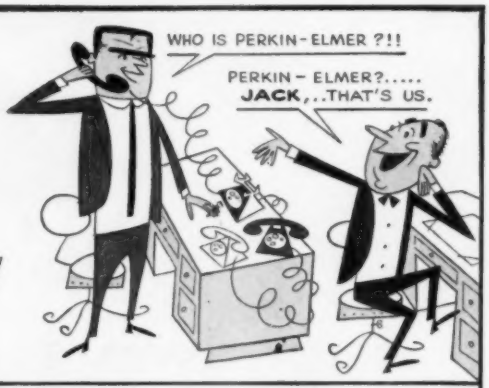
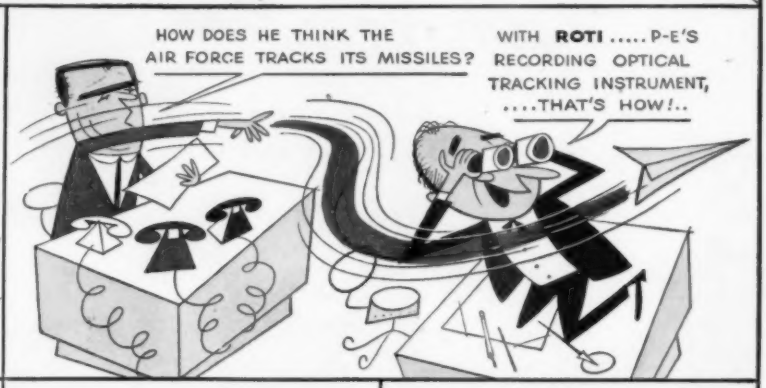
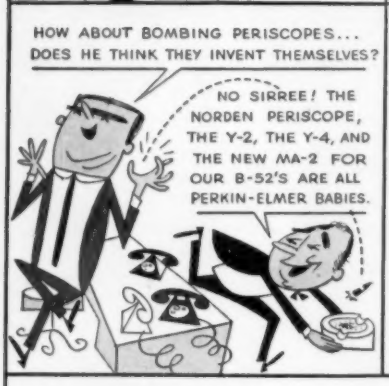
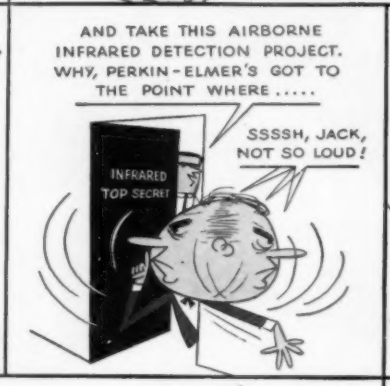
PERKIN-ELMER'S

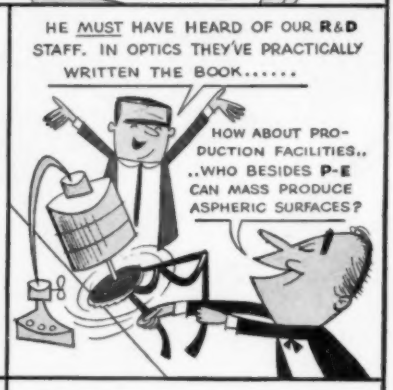
Jack and Charlie

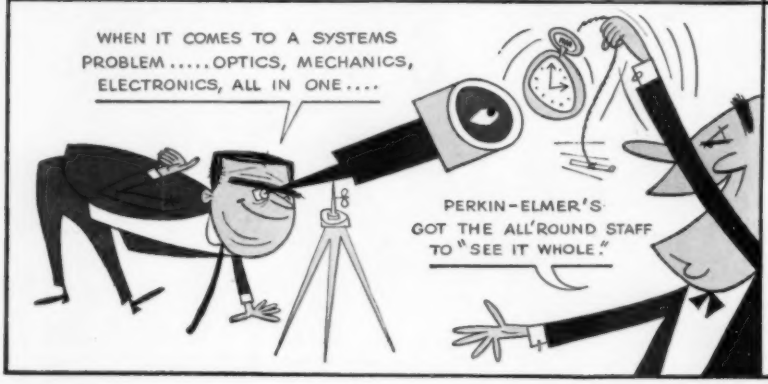


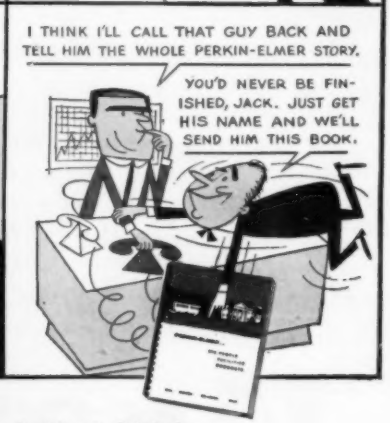



HOW ABOUT BOMBING PERISCOPES... DOES HE THINK THEY INVENT THEMSELVES?
NO SIRREE! THE NORDEN PERISCOPE, THE Y-2, THE Y-4, AND THE NEW MA-2 FOR OUR B-52'S ARE ALL PERKIN-ELMER BABIES.


AND TAKE THIS AIRBORNE INFRARED DETECTION PROJECT. WHY, PERKIN-ELMER'S GOT TO THE POINT WHERE .....
SSSSH, JACK, NOT SO LOUD!
INFRARED TOP SECRET


HE MUST HAVE HEARD OF OUR R&D STAFF. IN OPTICS THEY'VE PRACTICALLY WRITTEN THE BOOK.....
HOW ABOUT PRODUCTION FACILITIES.. ..WHO BESIDES P-E CAN MASS PRODUCE ASPHERIC SURFACES?


WHEN IT COMES TO A SYSTEMS PROBLEM.....OPTICS, MECHANICS, ELECTRONICS, ALL IN ONE....
PERKIN-ELMER'S GOT THE ALL'ROUND STAFF TO "SEE IT WHOLE."


I THINK I'LL CALL THAT GUY BACK AND TELL HIM THE WHOLE PERKIN-ELMER STORY.
YOU'D NEVER BE FINISHED, JACK. JUST GET HIS NAME AND WE'LL SEND HIM THIS BOOK.

Perkin-Elmer can bring your project to fulfillment sooner than you may now realize. For more information, write for "Perkin-Elmer . . . Its People, Facilities, Products."

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Engineering and Optical Division

Perkin-Elmer *Corporation*

Norwalk, Connecticut

On this heat-treating furnace at the Simonds Saw and Steel Co. plant in Fitchburg, Mass., door frames of gray iron buckled after three months. On the same furnace, ductile iron frames lasted a full year. Resisting oxidation and growth, and retaining good mechanical properties at elevated temperatures, ductile iron equipment outperforms by far that of gray cast iron. Ductile iron parts for Simonds were cast by Fitchburg Foundry, Inc., a subsidiary of Kingsbury Machine Tool Corp., Keene, N. H.

Ductile Iron outlasts gray iron 4 to 1 on furnace doors and frames

Furnace doors and frames of ductile cast iron help Simonds Saw and Steel Company cut heat-treating costs consistently. In three ways.

First, by *cutting the number of replacement parts needed* for their gas-fired heating furnaces that operate at 1800 to 2100°F. Previously, warpage shortened the life of brick-lined gray iron doors to eight weeks. Ductile iron doors now serve for 32 weeks.

Door frames made of ductile iron also give four times the life and need replacement only once a year.

Use of the ductile iron castings saves money in two other ways. It *saves costly brickwork*, and it *permits increased output* by reducing furnace downtime.

Ductile iron castings can help you where growth, scaling, cracking and distortion of parts needlessly increase your costs. For the facts about the combinations of properties offered by this material send for a copy of "DUCTILE IRON, The Cast Iron THAT CAN BE BENT!" It's full of helpful data. Write for your copy now.

Another way to cut costs. Simonds now uses ductile iron pots to hold molten lead at 1450°F. Where gray iron pots lasted three to four weeks, pots cast in ductile iron average 15 weeks of money-saving service. Ductile iron equipment in elevated temperature service often outlasts gray iron castings 10 to 1.

DUCTILE IRON

ductile iron . . . the cast iron that can be twisted and bent

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street, New York 5, N. Y.

FOR PEACE OR

★ ★ ★ Wherever oil wells are drilled, Ideco Full-View masts are familiar sights . . . outstanding in an industry known for both its rugged and exacting requirements. These examples of advanced engineering achievement are now modified to also serve as giant launching supports for the Army's long range Redstone missiles . . . a new defense role which strengthens the nation's program for preserving the peace.

This is only one of the many ways Dresser products and services work for you every day. The petroleum industry — so vital to our future — uses automation and seismograph systems from Southwestern Industrial Electronics . . . drilling muds and chemicals from Magcobar . . . technical oilfield services from Lane-Wells . . . pumps from Pacific . . . pipe couplings and fittings from Dresser Manufacturing . . . engines and compressors from Clark . . . positive displacement meters and rotary positive blowers from Roots-Connersville.

Dresser specialized products and technical oilfield services help to locate, surface and refine the oil that strengthens our defenses and provides us with literally thousands of products which make life more comfortable, more pleasant, more secure. In the oil, gas, chemical, electronic, and other industries, Dresser products and services have become the standard of comparison the world over. Write today for a free booklet about the Dresser story.

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DEFENSE

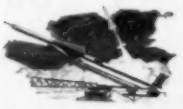
Tomorrow's Progress Planned Today!

OTHER IMPORTANT DEFENSE APPLICATIONS OF DRESSER PRODUCTS AND EQUIPMENT

Dresser Manufacturing Div. supplies flashwelded connecting rings for powerful jet engines used in military aircraft. Some types of aircraft engines require as many as 85 Dresser rings.

Roots-Connersville makes compressors and blowers for atomic submarines; gas pumps for atomic energy installations; blowers for "lifting bag" inflation to raise crashed aircraft.

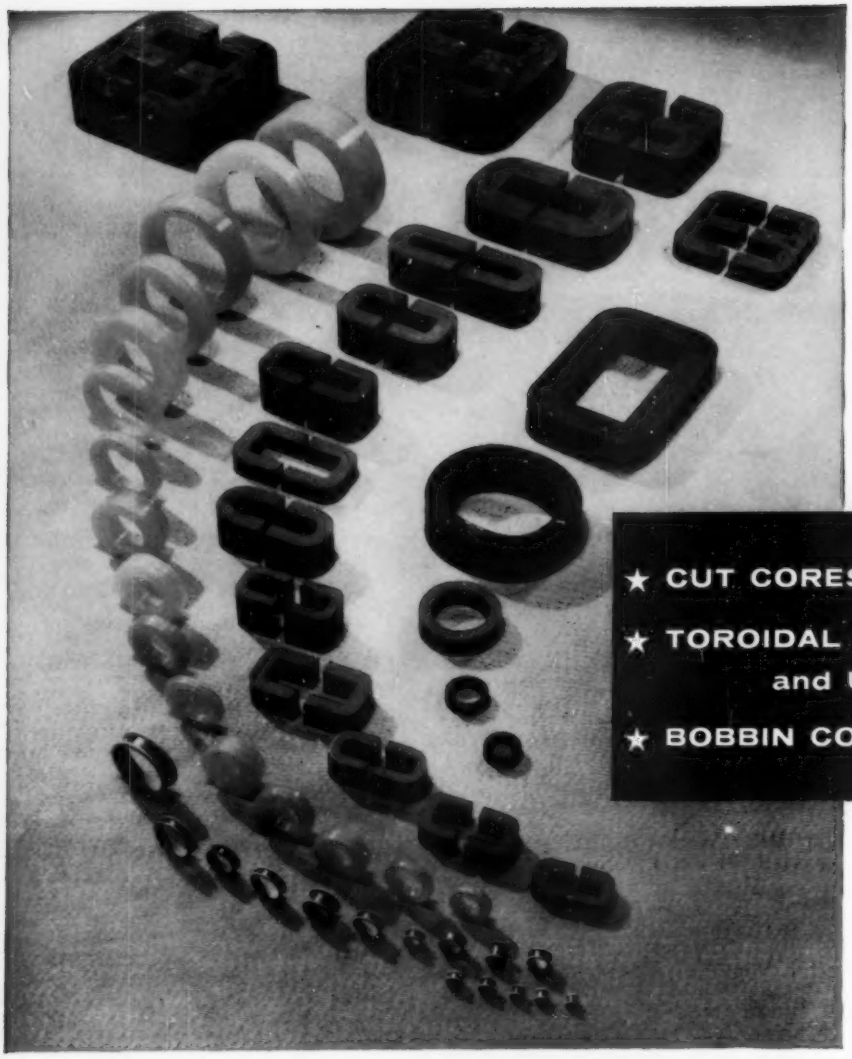
Clark Turbo-Mobile power plants, rail-mounted, supply emergency electricity for Navy Yards, docks, hospitals, and major disaster areas. Unit has capacity of 5500 kilowatts, enough power for a city of 12,000.



High pressure compressors from Clark . . . instrumentation and other electronic equipment from Southwestern Industrial Electronics . . . are used in guided missiles and many other important military applications.

Dresser-Ideco supplies structural equipment used in military defenses, including radar outposts for our remote Arctic warning system as well as microwave, radio and television towers.

Pacific provides the Navy with Turbo pumps for ships' main and boiler feed pumps. Equipment from other Dresser companies is also used on both merchant ships and naval vessels.



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★ TOROIDAL CORES, Cased and Uncased

★ BOBBIN CORES

It's ARNOLD for EVERYTHING in TAPE-WOUND CORES

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MATERIALS: Deltamax, 4-79 Mo-Permalloy, Supermalloy, Mumetal, 4750, Monimax, Silectron, Permendur: all are available for cores depending upon the specific properties required.

GAUGES: The following standard tape thicknesses are available for Arnold tape wound cores in most of the magnetic materials mentioned above: .012", .004", .002", .001", .0005", or .00025". Bobbin cores are made from tape .001" to .000125" thick.

SIZES: Cores weighing from a fraction of a gram to many hundreds of pounds can be supplied. Toroidal cores are made in 27 standard sizes with nylon cases. Types "C" and "E" cut cores are made in a total of 530 standard sizes. Many special sizes and shapes of both gapless and cut cores are manufactured for unusual requirements.

OTHER PRODUCTS: In addition to Tape-Wound Cores, we also produce a complete line of Mo-Permalloy Powder Cores, Iron Powder Cores, and permanent magnets. • *Let us work with you.*

WAW 5818 B

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Today, it takes the helping hands of diversified industries united under one progressive management.

. . . A management that has the background to cut costs and step-up production, and at the same time insure quality leadership for each and every product.

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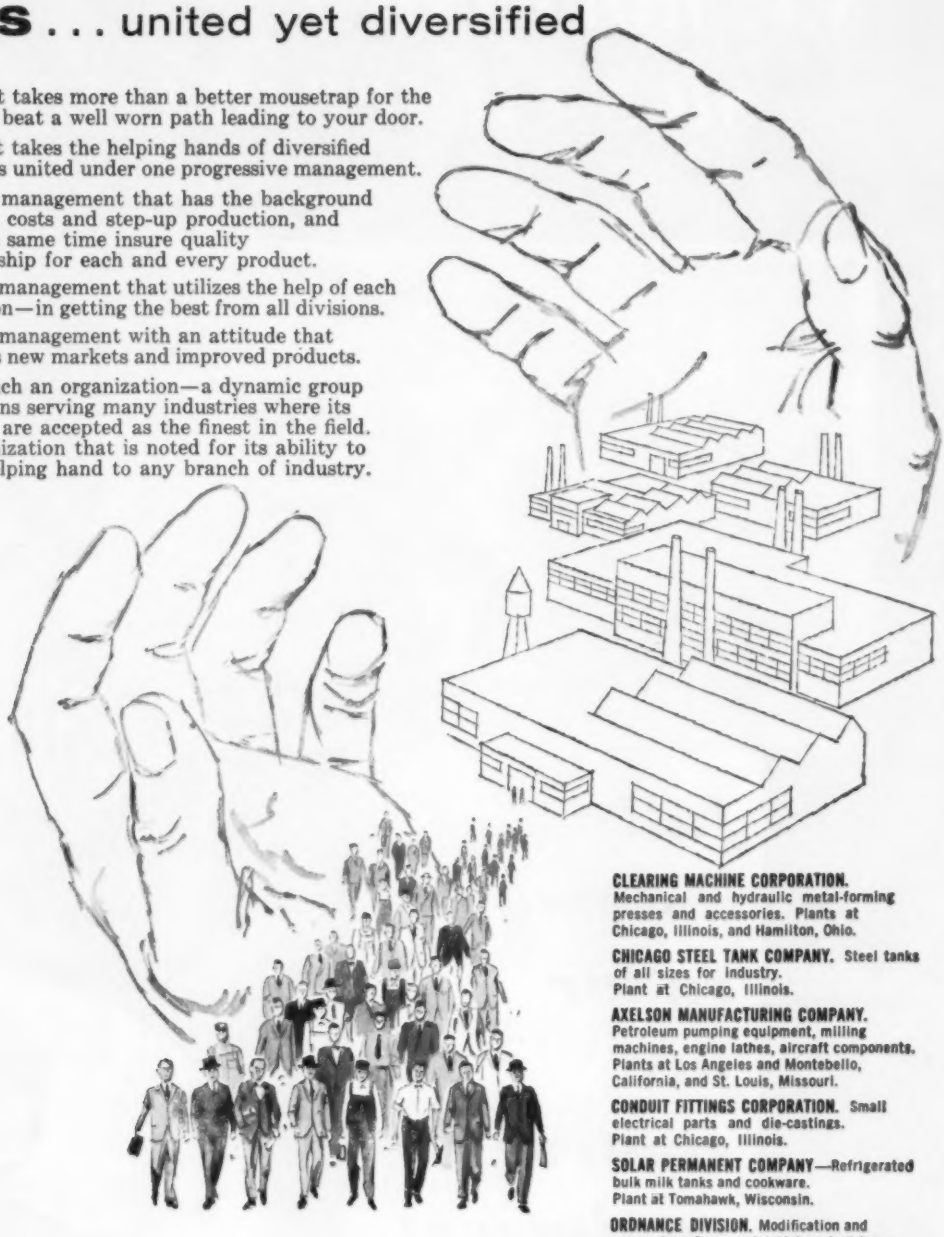
USI is such an organization—a dynamic group of divisions serving many industries where its products are accepted as the finest in the field. An organization that is noted for its ability to give a helping hand to any branch of industry.



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A MEMBER OF THE OMAR TEAM

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ALCO SUPPLIES VITAL

▲ **CURRENT PRIME CONTRACTOR FOR ARMY'S M48A2 TANK,** ALCO assembles components of some 1500 subcontractors and mass-produces the medium tanks in facilities that have already delivered almost 10,000 tank vehicles.

ROCKET FUEL CHAMBERS FOR THE "HONEST JOHN" are produced by ALCO in volume quantities. The prime contractor and government agencies have commended ALCO for expert fabrication and speed of delivery. ▼

COMPONENTS FOR ALL THREE SERVICES

Items range from missile launchers and missile propellant chambers to weldments and springs; ALCO is also prime contractor for tanks and atomic power plant

As a prime contractor, ALCO is currently producing the Army's M48A2 medium tanks and working on the Army Package Power Reactor which will be completed early next year. ALCO also produces highly complicated components for other prime contractors; heavy final drives for tanks, air flasks, propellant chambers and missile launchers, to name a few.

Long experience in defense production, beginning in 1860, is one reason why ALCO is successful in helping make modern weapons. Its products have included guns, shell casings, locomotives and marine diesels. During World War II and Korea, ALCO made thousands of combat tanks.

Complete production and design facilities are another important reason for ALCO leadership. Seven plants in five states are fully equipped to produce heavy weldments, heat-transfer items, diesel engines, pressure containers and vessels, springs, forgings, rings, precision-machined items and all types of assembly, including electronics. ALCO also offers specialized design experience in atomics and weapon development.

Call on ALCO for assistance on new defense items. Complete information about facilities and engineering is available from your nearest ALCO Sales Office or write P.O. Box 1065, Schenectady 1, New York.

ALCO

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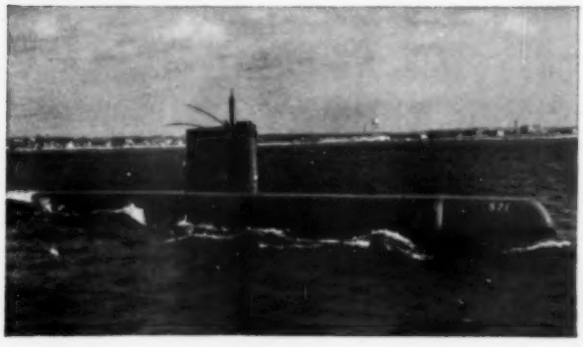
NEW YORK

Locomotives • Diesel Engines • Nuclear Reactors • Heat Exchangers
Springs • Steel Pipe • Forgings • Weldments • Oil-Field Equipment

◀ **ROCKET BOOSTERS FOR THE U.S. AIR FORCE "SNARK" SM-62** are produced by ALCO under a subcontract. The Snark, shown here taking off on a test flight, has intercontinental range, plus the ability to carry an atomic warhead.

HEAT EXCHANGERS FOR ATOMIC SUBMARINE were built by ALCO. ALCO also supplied the design and manufacturing facilities that helped solve the difficult heat-transfer problems posed by the *Nautilus'* specialized reactor system. ▼



▲ **ARMY PACKAGE POWER REACTOR,** now under construction at Fort Belvoir, Va., will be completed in early 1957. ALCO is prime contractor. APPR has been designed so that all components can be transported by air to remote areas for installation.

Farquhar... the first triple-acting press with electric magnetic controls...

EVERY ADJUSTMENT of speed, timing and pressure is made by the operator on this Control Panel without leaving his operating station. It is no longer necessary for him to climb to the top of the press for this purpose.

...the only press that can do so many things so well

THIS hydraulic press revolutionizes the high speed production of draw-formed parts. We believe that it has rendered obsolete every double-acting and triple-acting press now in service. These are challenging statements... *but read the facts.*

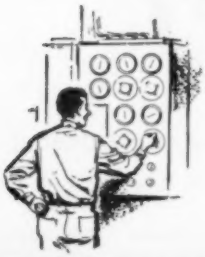
A. B. Farquhar Division, The Oliver Corporation
Press Department, York 33, Pennsylvania

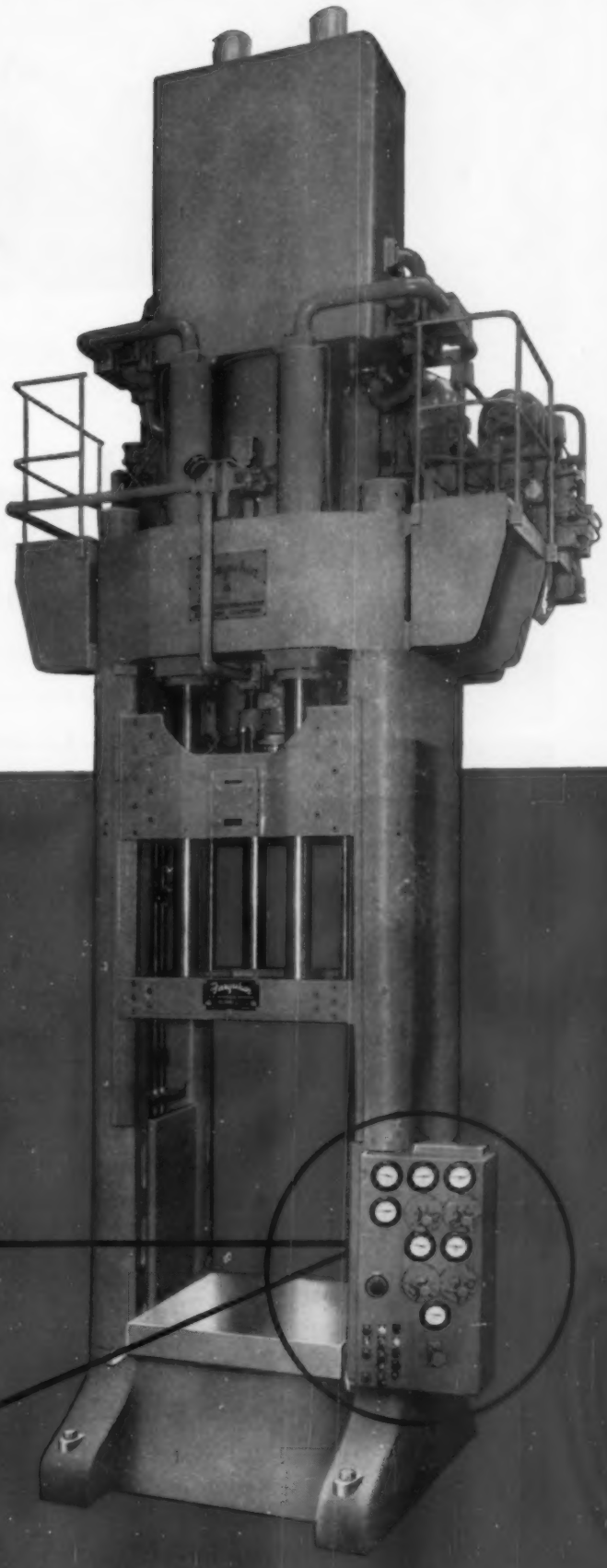
OLIVER

Farquhar PRESSES

DRAWING • FORMING • FORGING • STRAIGHTENING • BENDING

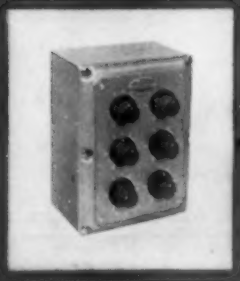
- **Unlimited speed changes** now possible at any point in the cycle. This means, for example, that the ram can approach the draw at maximum speed, slow down as it enters the draw, change speed in the middle of the draw, strip slowly and return to up position at maximum speed.
- **Draw-forming of difficult materials** is thereby greatly simplified and improved. The exact speed can be selected which is best suited to the characteristics of the material at any point in the stroke.
- **Expensive dies** can be given added protection by "gentle" treatment at point of contact and withdrawal.
- **Cycle time is greatly reduced,** because maximum speeds can be attained at every desired point in the cycle.
- **No expensive cams** with time-consuming adjustments are needed to obtain these results. All speed changes are made by dial settings on the control panel.



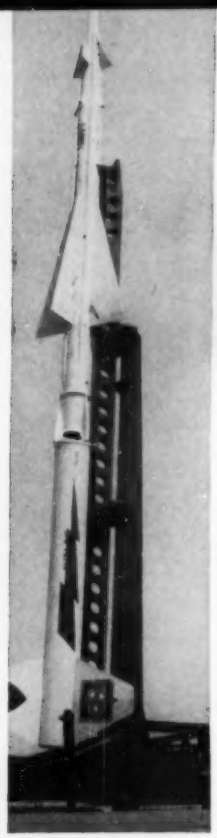


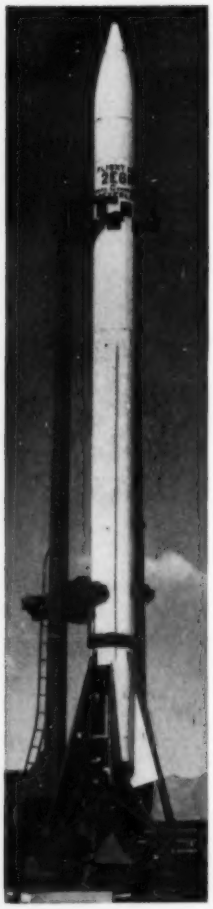
- **4-point adjustment of blank holder pressure** is made by operator without leaving operating station, an important device in the draw-forming of eccentric shapes. This has been a feature of Farquhar Double-Acting Presses in the past. It is an important feature of the new Farquhar Double and Triple-Acting Presses, too.
- **Best of all,** with these additional advantages, the Farquhar Double and Triple-Acting Presses are competitively priced!
- **For a more complete description** of these new Farquhar Presses with electric magnetic controls, write for Bulletin A-200. Please use your company stationery. A. B. Farquhar Division, The Oliver Corporation.

Speeds are pre-set by these radio-type dials which can be located within the main control panel or in a remote position.



FORCING • ASSEMBLING • EXTRUDING • AND OTHER OPERATIONS





Bring a friend to Aberdeen

on

ordnance day

October 4, 1956

The big Thirty-eighth Annual Meeting of the American Ordnance Association will be held at Aberdeen Proving Ground, Maryland on Thursday, October 4. Guided missiles, rockets, tanks, guns, fire control, and other modern armament will be displayed and tested for A.O.A. members.

Bring an interested friend. If he is not an A.O.A. member have him send in this application right away. (*To attend he must be a member and have an Ordnance Day reservation by September 26.*)

USE THIS APPLICATION TODAY

AMERICAN ORDNANCE ASSOCIATION
708 Mills Building, Washington 6, D. C.

APPLICATION FOR MEMBERSHIP

I hereby apply for individual membership in the American Ordnance Association and enclose annual dues ($4.00 for one year, or $10.00 for three years) which include all publications of the society and all other membership privileges. *I certify that I am a citizen of the United States.*

NAME .....
Print Plainly

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Street and Number

.....
City, Zone, State

COMPANY ..... **POSITION** .....

☐ Send Ordnance Day Reservation form by return mail. I-470

Recommended by _____

Don't Miss the A.O.A. Annual Meeting October 4

Q: *How to heat vehicles?*

Q: *Chilly day at Thule (−50°F.) . . . how to start fire-crash truck within seconds, provide 90,000 Btu/hr. in small space?*

A: Janitrol liquid heater (tested to −65°F.) keeps engine ready to go, provides cab and cargo heating too!

Q: *How to find money to build heated storage buildings for Diesel bus fleet?*

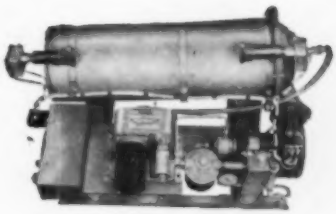
A: No need to find it, park the fleet outside —Janitrol liquid heaters keep engines, and bus interiors warm, ready to go at a fraction of cost of new building.

A:

A: Call on Janitrol. If there's a need for heat for the job anywhere, chances are Janitrol can supply it, or build it from service-proved components.

Ever since designing and manufacturing the first successful heaters for aircraft 14 years ago, Janitrol has built thousands of heaters for aircraft and ground vehicles.

Today the name Janitrol stands for leadership in heating equipment and combustion engineering. Your Janitrol representative is always at your service.



Janitrol

AIRCRAFT-AUTOMOTIVE DIVISION, SURFACE COMBUSTION CORPORATION, COLUMBUS 16, OHIO

DISTRICT ENGINEERING OFFICES: WASHINGTON, D.C., PHILADELPHIA, COLUMBUS, FT. WORTH, HOLLYWOOD

Solar builds world's largest wind tunnel bellows

GIANT BELLOWS that absorb the supersonic stresses of wind tunnels are a Solar specialty. Solar builds them—in sizes greater than 25 ft in diameter—for many government and private test facilities. These Sola-Flex joints exemplify Solar's increasingly diversified services for the aircraft industry. For more information, write Dept. C-54, Solar Aircraft Company, San Diego 12, Calif.

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SOLAR
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DESIGNERS, DEVELOPERS AND MANUFACTURERS OF BELLOWS • GAS TURBINES • METAL ALLOY PRODUCTS • CONTROLS • HIGH TEMPERATURE COATINGS • AIRCRAFT COMPONENTS

COLLINS RECEIVER / TRANSMITTER

LEADS THE *TACAN* PROGRAM

Superior accuracy and reliability characterize the rugged ARN-21 (XN-10) developed by Collins for the Navy Bureau of Aeronautics. The accuracy of this TACAN unit is above that of test equipment normally used for military electronics. Precise information is assured by greatly advanced bearing and distance circuits. Pressurized for very high altitude, the Receiver/Transmitter features improved cooling and modular construction for ease of maintenance and packaging flexibility. Collins ARM-22 TACAN test set, also developed for the Navy, is of the high order of accuracy the TACAN equipment demands.

Collins CREATIVE LEADER IN AVIATION ELECTRONICS

COLLINS RADIO COMPANY, 315 2ND AVE. S.E., CEDAR RAPIDS, IOWA • 1930 HI-LINE DRIVE, DALLAS 2 • 261 MADISON AVENUE, NEW YORK 16 • 2700 W. OLIVE AVENUE, BURBANK • 1200 18TH ST. N.W., WASHINGTON, D.C. • 4675 N.W. 36TH ST., MIAMI 42 • 1318 4TH AVE., SEATTLE

COLLINS RADIO COMPANY OF CANADA, LTD., 11 BERMONDSEY ROAD, TORONTO 16, ONTARIO, CANADA

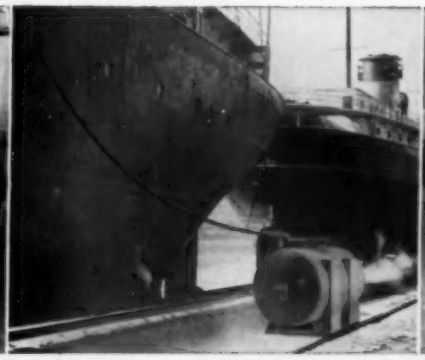
COLLINS RADIO COMPANY OF ENGLAND, LTD., 242 LONDON ROAD, STAINES, MIDDLESEX

Here's *MASS-HANDLING* of bulk

What you see above is a Dempster-Dumpster serving one of its detachable containers. Multiply this simple pick up, haul and dump operation by scores of steel containers built to meet your requirements for handling waste or salvable materials, raw and finished products, fluids including acids, combustibles, dusty materials, etc. You have, then, mass-handling of bulk materials with one truck and one man!

Tilt Type Container is handling filter dirt at a plant in Illinois. Note container is equipped with casters and placed under chute, through which the filter dirt passes directly from presses. As each container is filled, it is replaced with an empty one.

Three heavy duty Drop Bottom Type Containers, shown below, are loaded with cast iron fittings from conveyor at plant in Birmingham. Dempster-Dumpster picks up each container when loaded and hauls the finished products to shipping department.

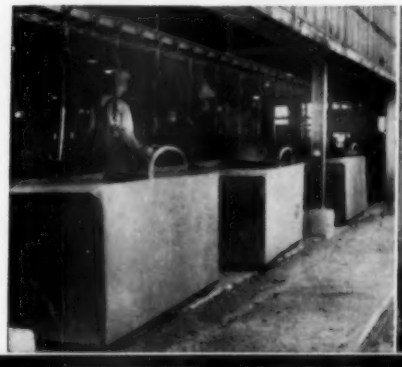


Tank Type Container is being filled with used oil from a ship. Time required to haul loaded container to reclaim station, drain and return for refilling—10 minutes. Time cycle of the former method using conventional barrels—60 minutes.

Here's another example of the many types of waste materials handled by this system. The Skip Type Container shown below is located under hydropulper at a paper plant. Picture was shot while container was being filled with rope waste sludge.

A loaded Apartment Type Container, equipped with roller bearing casters, is being rolled to outside of this plant building. Dempster-Dumpster will pick it up, haul to disposal area, dump the refuse and return empty container for refilling.

Waste materials are loaded into these Universal Containers at a food plant warehouse. Containers have lids in top, as well as a door in each end, which are opened to make deposits, then closed, sealing materials in container.



materials with one truck...one man!

A FEW OF THE HUNDREDS of containers available are shown above in actual service. They are built in capacities up to 21 cu. yds.—several times the capacity of the average dump truck body. One Dempster-Dumpster, operated by only one man, the driver, serves scores of big detachable containers, one after another—handling materials of every description. It's like having one truck with scores of bodies!

Records of performance in dozens of installations prove beyond question that savings are tremendous! The Dempster-Dumpster System cuts costs of equipment and operation. It is common knowledge that one Dempster-Dumpster will perform the work of several conventional trucks, reducing investment accordingly. This system eliminates standing idle time and re-handling of materials. Once placed in these containers, materials remain there until hauled to destination. Efficiency, sanitation and good plantkeeping are big advantages. Materials to be transferred or disposed of are constantly being placed in the containers as they accumulate. Containers for handling refuse are fire-proof, rat-proof and scavenger proof.

With no obligation on your part, our engineers will be glad to make a comprehensive fact-finding survey to determine the cost-cutting possibilities of this equipment in your plant. Write us for complete information today! Manufactured exclusively by Dempster Brothers, Inc.

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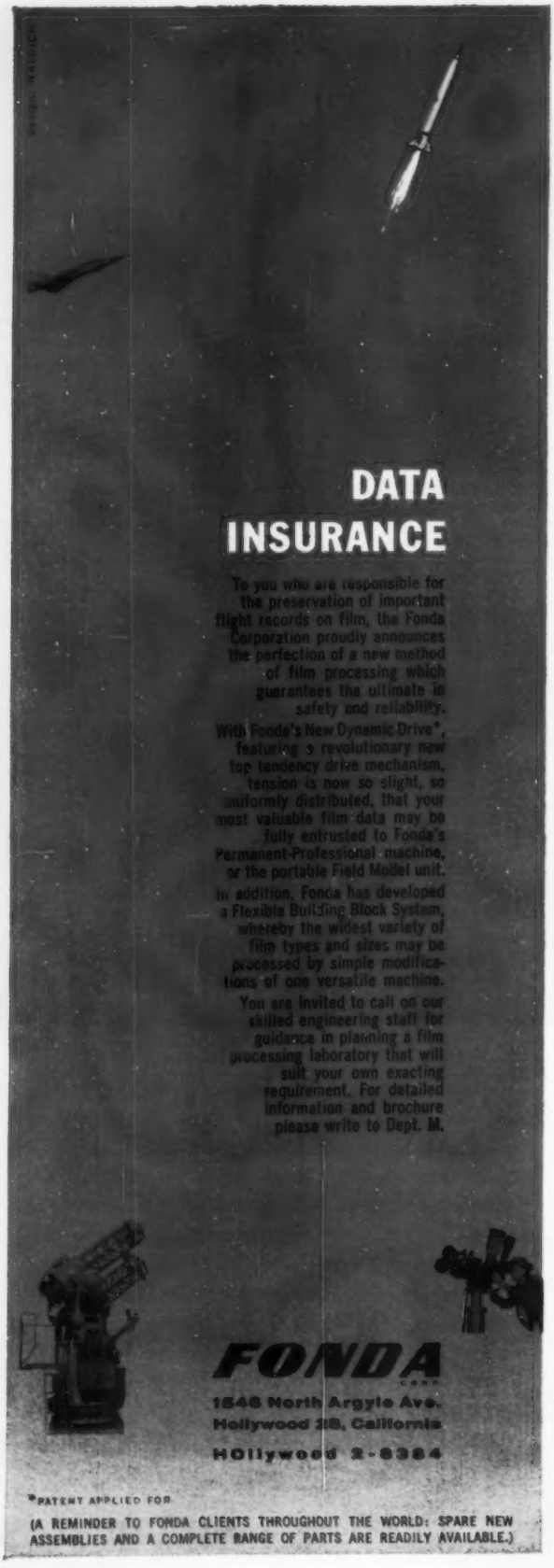
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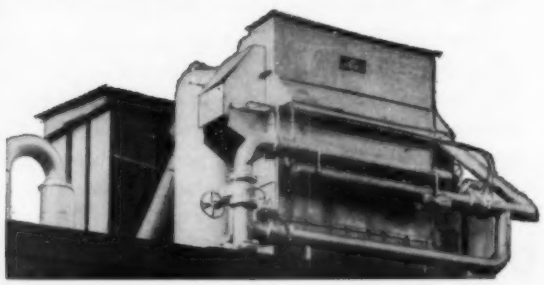
The NIAGARA AERO AFTER COOLER assures these benefits because it cools compressed air or gas below the temperature of the surrounding atmosphere so there can be no further condensation in air lines.

Direct saving of cooling water saves you the price of the Niagara Aero After Cooler in less than two years.

Write for Bulletin No. 130

NIAGARA BLOWER COMPANY

Dept. O, 405 Lexington Ave., New York 17, N. Y.



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TWO GREAT COMMANDERS IN THE SERVICE OF THE U. S. AIR FORCE

The L-26B and the Supercharged L-26C are designed and produced by the manufacturers of Aero COMMANDER Model 560-A and Model 680-Super —twin-engine executive transports in the service of business and governments around the World.

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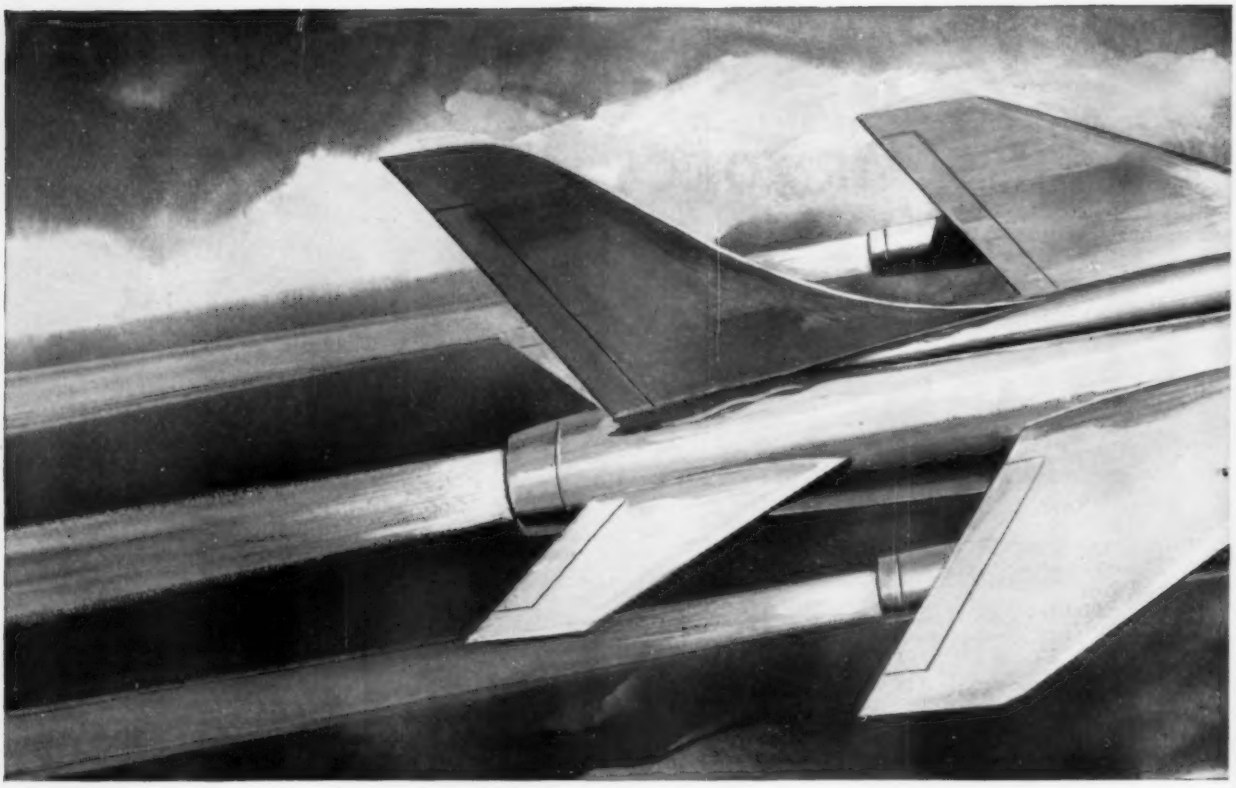
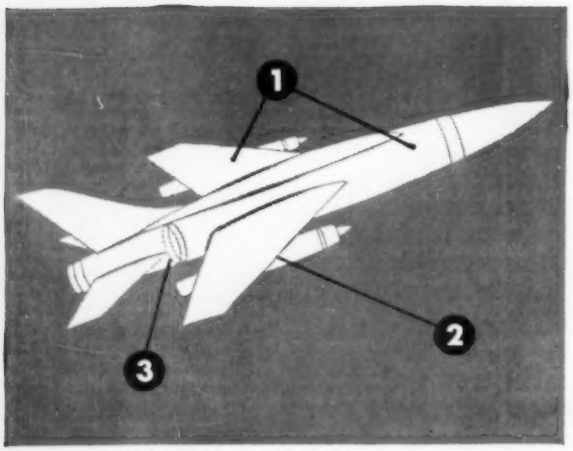
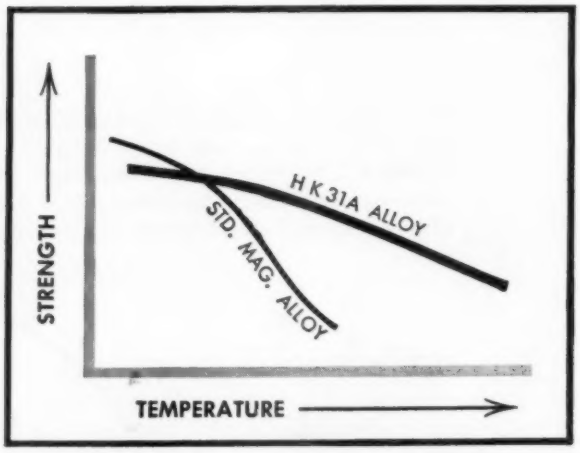
NEW DOW MAGNESIUM ALLOYS





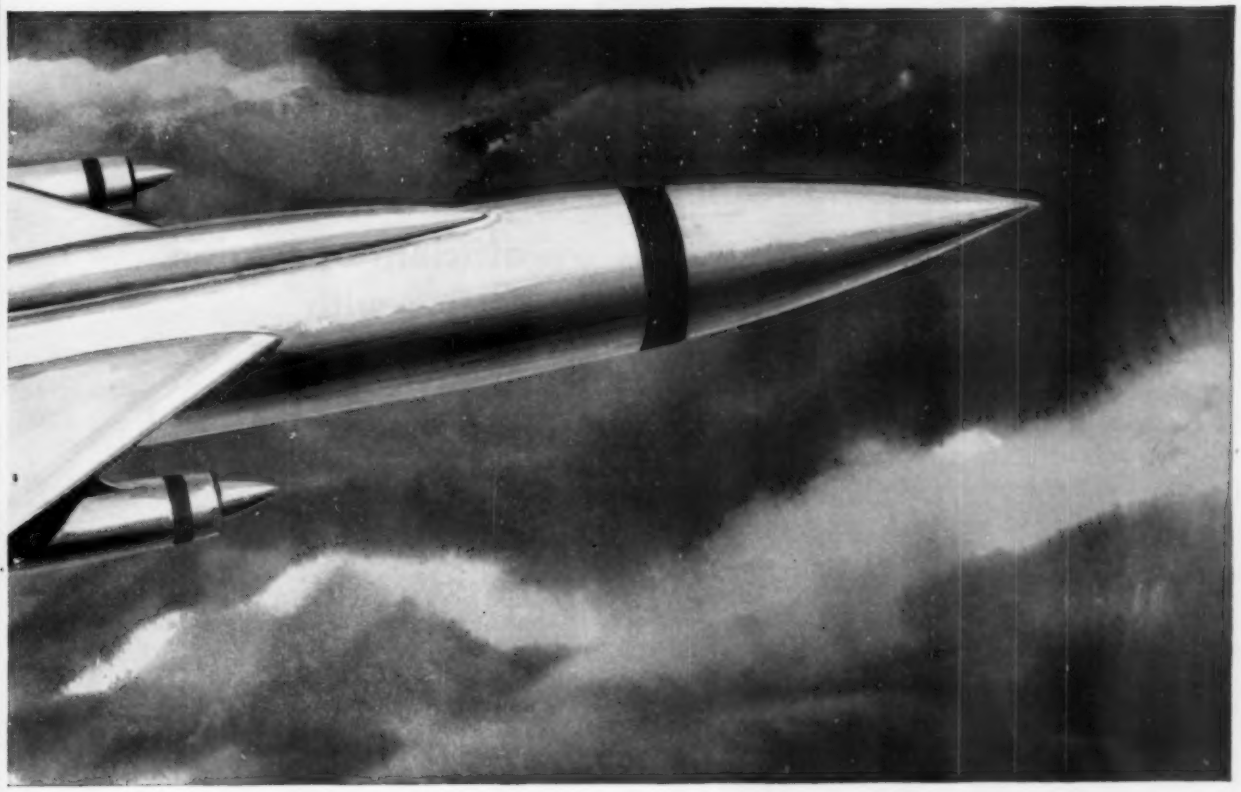
Now suggested *for a broad range of uses in missiles and aircraft, the new Dow magnesium alloys are available in the form of (1) sheet or plate, (2) extrusions, (3) castings.*



Maintenance of strength *at high temperatures is illustrated by this chart. Performance data on the new alloys at elevated temperatures can be obtained by request.*

DOW

CRACK HEAT BARRIER!



High temperature magnesium alloys are available to lighten aircraft and missile structures

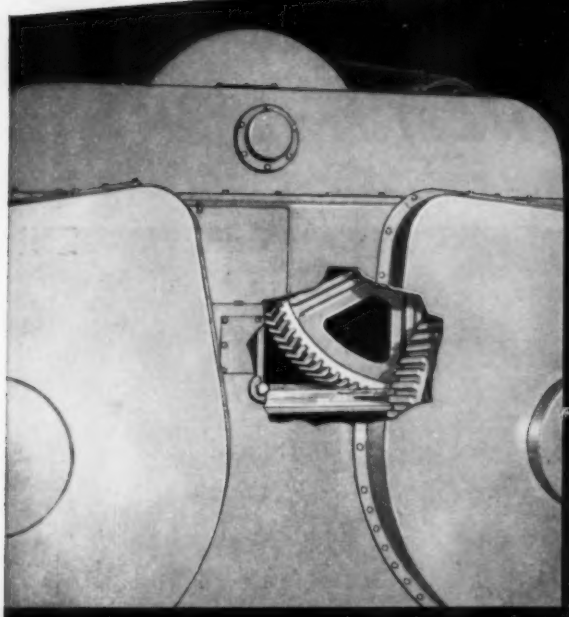
Once again the horizons for aircraft structural design have been widened. Dow has developed a series of high temperature magnesium alloys which are already in pre-production use on aircraft, missile and engine structures. These alloys show advantages at temperatures up to 700° F. Limited test data on properties up to 800° F. are available for some of these alloys.

The new alloys save precious pounds because of their good combination of modulus and properties, including creep strength, at temperature. Shop characteristics include good formability and weldability.

One of the available alloys is the magnesium-thorium composition, HK31A, which is manufactured in rolled and cast form. Under development is a similar alloy for extruded shapes and forgings. HK31A sheet and plate are available from stock and from current mill delivery schedules in standard sizes from 0.016″ to 2″.

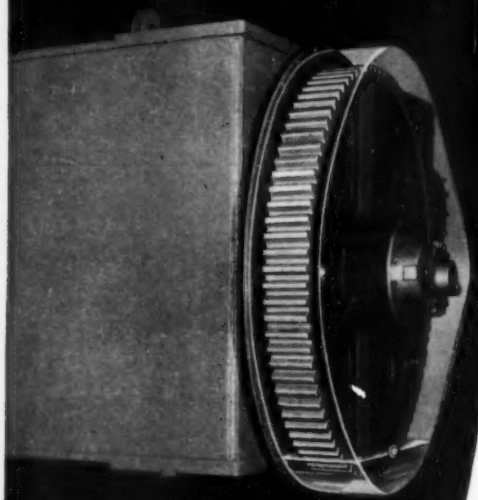
These new magnesium alloys by Dow should be considered for your high temperature requirements. Contact your nearest Dow sales office or write THE DOW CHEMICAL COMPANY, Magnesium Sales Dept., MA 361H, Midland, Michigan.

you can depend on DOW MAGNESIUM DOW



Cutaway showing how herringbone intermediate gears operate in oil bath within the crown.

Cutaway showing Verson main gears and the oil bath in which they operate.



A Verson Press for every job from 60 tons up.

These are the features **that make -Verson- presses your best buy**

DRIVE GEARS

operate in oil bath to assure long life and smooth, efficient operation with

-Verson- PRESSES

As the cutaway views at the left show, drive gears in Verson presses are fully enclosed and operate in an oil bath.

This is the positive way of insuring effective lubrication. Each tooth of the gear passes through the oil on each revolution to pick up its protective film of oil. For the press user, it is the kind of protection that means smooth, efficient operation throughout a long, trouble-free life.

Gears operating in oil is just one of the many advantages built into Verson Presses to give the user more and better stampings at lower overall cost. Whether you require a single press or an entire stamping plant complete with tooling, be sure to get the whole story of what Verson quality can mean to you.

For specific recommendations, send an outline of your requirements.

Catalogs are available describing the Verson lines. Please write for yours, mentioning the types of presses in which you are interested.

TRADE Verson MARK

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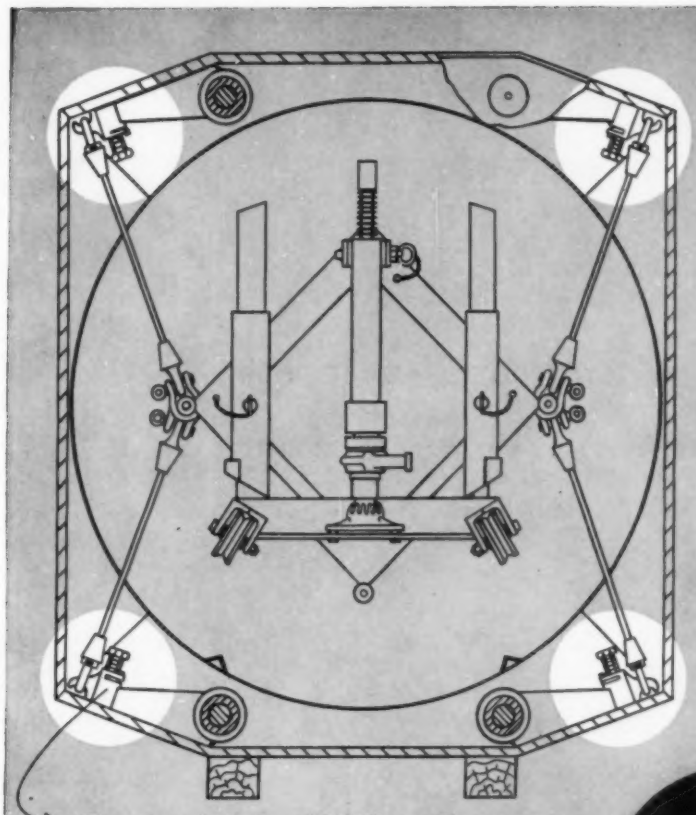
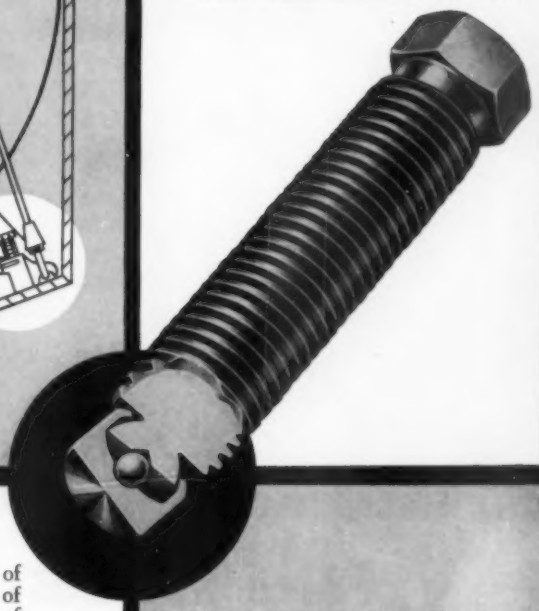


Vlier makes only the Swivel-Pad Clamps. The container is a product of American Pipe and Steel Corporation, Alhambra, California.

Vlier Ball-joint clamps

solve clamping problem for missile container manufacturer



The remarkable ball-joint design now used in thousands of Vlier Swivel-Pad Clamps can be adapted to a variety of clamping and holding applications. The drawing above of a missile shipping container demonstrates one adaptation which solves a particularly difficult problem. Eight special Vlier Swivel-Pad Clamps are used to release tension on cables which suspend the missile in its shipping container. Radar manufacturers are also using special Swivel-Pad Clamps to prevent damage to sensitive instruments during shipment.

PROTECTS SURFACE OF THE PART

The main advantage of the Vlier Swivel-Pad Clamp is that it exerts extreme holding pressure without damaging the surface of the object held. First touch of the pad against the object adjusts the pad face angle and stops pad rotation. The pad can then be tightened to hold the object securely, since the screw torque is absorbed by the pad, not the object.

Perhaps this unique Vlier ball-joint principle can be applied to your clamping problems. Vlier engineers will welcome your inquiries.

BALL-JOINT CONSTRUCTION—Eliminates binding, assuring proper adjustment of the pad against an off-angle surface. The pad swivels 7½° in all directions each side of the center line.

SPECIAL PAD AND SCREW DIAMETERS AVAILABLE—Normally pads are machined from solid stock and are not relieved or counterbored. However, other shapes, sizes, etc., can be designed to meet specific needs.

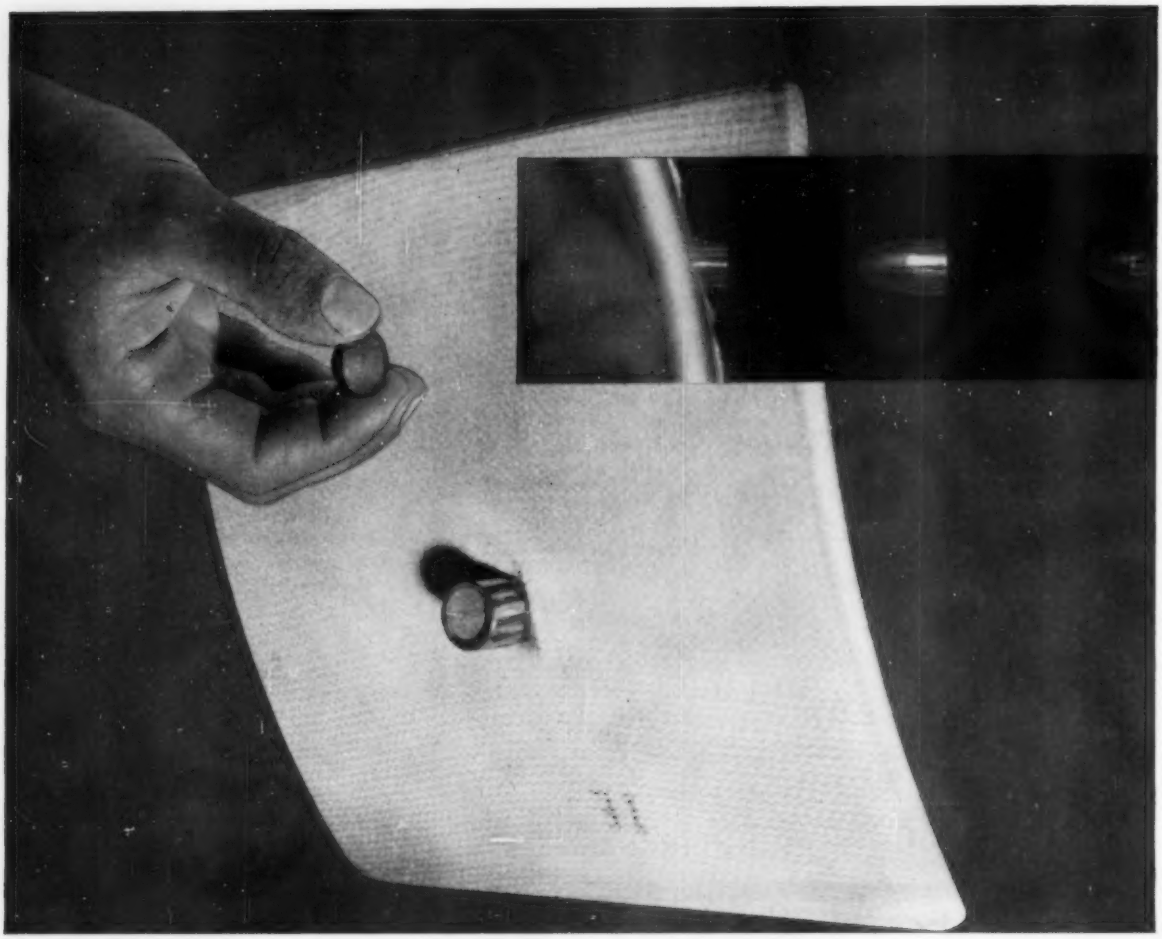
EXCELLENT STRENGTH—Screws are made from heat-treated alloy steel. Ball-joints have been designed to withstand as much as 21,000 load pounds (1" screw diameter).

VARIETY OF FINISHES POSSIBLE—Standard Swivel-Pad Clamps are Du-lited: however, cadmium, iridite, and other finishes to meet government specifications can be provided.

Insist on Vlier Tooling Accessories...
there's still no substitute for quality.

VLIER ENGINEERING INCORPORATED

8900 Santa Monica Boulevard
Los Angeles 46, California



Mashes .45 slugs at point blank range!

Air Cruisers plastic armor only 1/8 inch thick stops .45 calibre bullets fired from only five feet away

Battle-tested in Korea, plastic body armor reduced shrapnel fatalities by 70%. It is only one of several glass fiber polyester laminates manufactured by AIR CRUISERS. All are outstanding in their strength-weight relationships, are very easily worked and have outstanding structural possibilities.

Projected armor applications include protective panels for crews and engines, instrument panels, seat buckets, fairings, ammunition chutes and disposable gas tanks. These glass fiber polyester laminates are molded in either standard sheets or intricate shapes. They can be utilized wherever extreme strength in relation to weight and bulk is desired.

We shall be happy to provide engineering consultation and assistance in adapting these materials to your present and future needs or purposes.

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Prove by comparison tests how Parker O-rings seal better and last longer

For trouble-free leakproof sealing, you can depend on Parker O-rings. They are precision molded of superior compounds that have been developed as the result of thousands of tests.

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From Parker you can get exactly the *right* O-ring for your *specific* application. We invite you to compare Parker O-rings with any other make. Our engineering service will also help you with designing problems.

Send for complete engineering data today. Mail the coupon for your *free* data book or ask your Parker O-ring distributor for a copy.

RUBBER PRODUCTS DIVISION
The Parker Appliance Company
17325 Euclid Ave., Cleveland 12, Ohio
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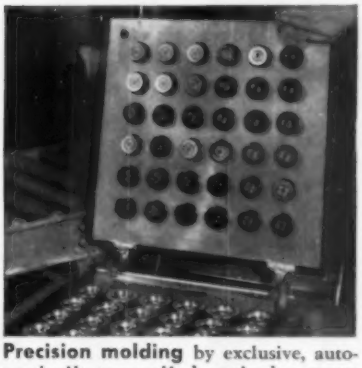
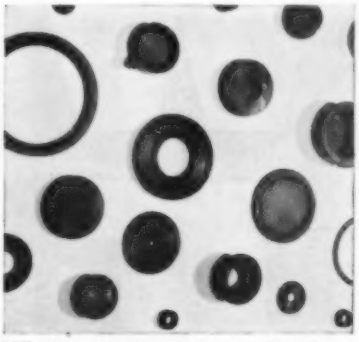
Hydraulic and fluid system components

Laboratory and service tests check compound resistance to oils, fuels and chemicals at high and low temperatures ... assuring the long life of Parker O-rings.



Precision molding by exclusive, automatically controlled methods assures close-tolerance fits. Parker has molds for 296 *standard* O-ring sizes. Send for data.



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Section 518-S
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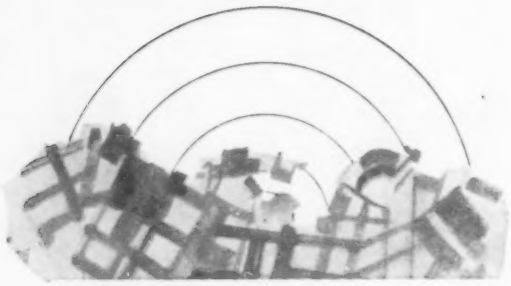
☐ O-ring Catalog No. 5701
☐ Custom-molded Rubber Cat. No. 5810

NAME_____ TITLE_____
COMPANY_____
ADDRESS_____
CITY_____ STATE_____



...and the U.S. Navy's Offshore Patrol that guards America

While you work, while you play, while you sleep—though any threat to your way of life be the farthest thing from your mind—the U. S. Navy is in action in the air along America's shores, protecting the peace you enjoy. This particular phase of Naval Aviation is the job of the Navy's "Offshore Patrol". . . and Curtiss-Wright power is everywhere in the picture.

Curtiss-Wright Turbo Compound® powered Lockheed Super Constellation WV early warning radar planes, and Lockheed Neptune P2V and Martin Marlin P5M long-range reconnaissance planes cruise far out to sea—day and night, ever watchful. Cyclone 9-powered Grumman Tracker S-2F sub hunters and Sikorsky HSS helicopters range closer in, providing a tight defense ring against invasion. Cyclone 7s power Vertol HUP helicopters, and Goodyear CPG blimps with Curtiss Electric Propellers. The resultant "protection perimeter" extends from the Arctic Ocean south around the entire continent.

These Curtiss-Wright aircraft engines—plus Curtiss-Wright jet and rocket power—are ready if anything disturbs the peace. Meanwhile, they help you to work and play in confidence, sleep soundly.

YOUNG MEN! BECOME A NAVAL AVIATOR

Apply at any Naval Air or Recruiting Station

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UNITED STATES STEEL CORPORATION
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NITROCYCLE PROCESS
UNITED STATES STEEL

Wear the ORDNANCE TIE

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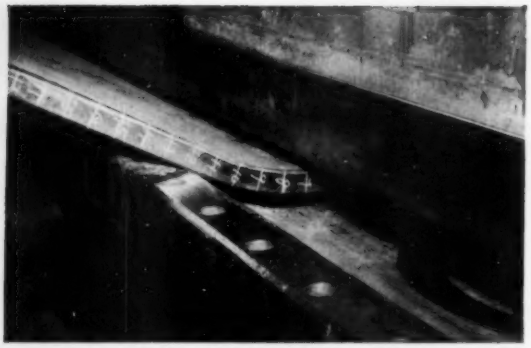
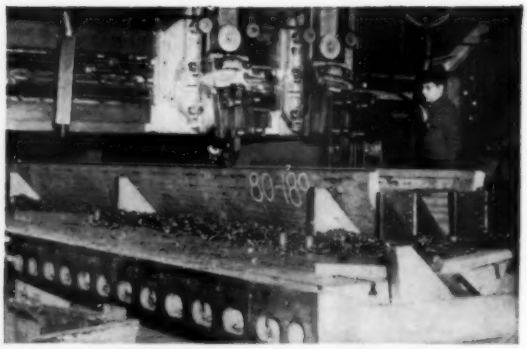
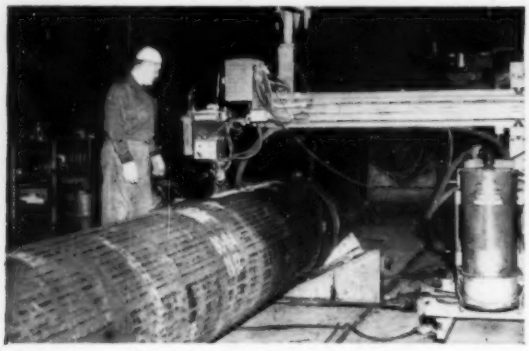
FOSTER WHEELER FABRICATES "T-1" STEEL



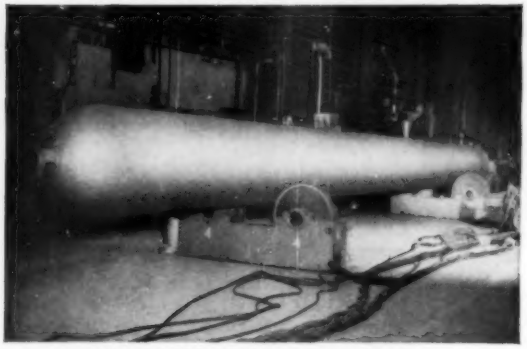
Bending 2 in. "T-1" steel plate on 8000-ton beam press



Machining mating surfaces of half shell



Automatic welding of exterior seam



One of nine vessels nearing completion

THE FORMING and welding of high-yield-strength "T-1" steel has been extensively investigated by Foster Wheeler and a number of pressure vessels have now been successfully fabricated of this new material. Operations in the manufacture of one of these vessels are shown above.

The 8000-ton beam press at Foster Wheeler's Mountaintop, Pa., plant was used to form the flat "T-1" steel plate, 2 in. thick, into half shells which were machined and welded into a full cylinder. Bending techniques were developed and conservative limits established to control maximum bending stresses. The toughness of the steel was unaffected by cold bending within these established limits.

After exploring several welding processes, the automatic submerged melt technique was found most satisfactory, meeting the required joint efficiency of 100 percent in the stress relieved condition.

For end closures, where inside back welding could not be used, a procedure was developed for 100 percent penetration welding without backing strips.

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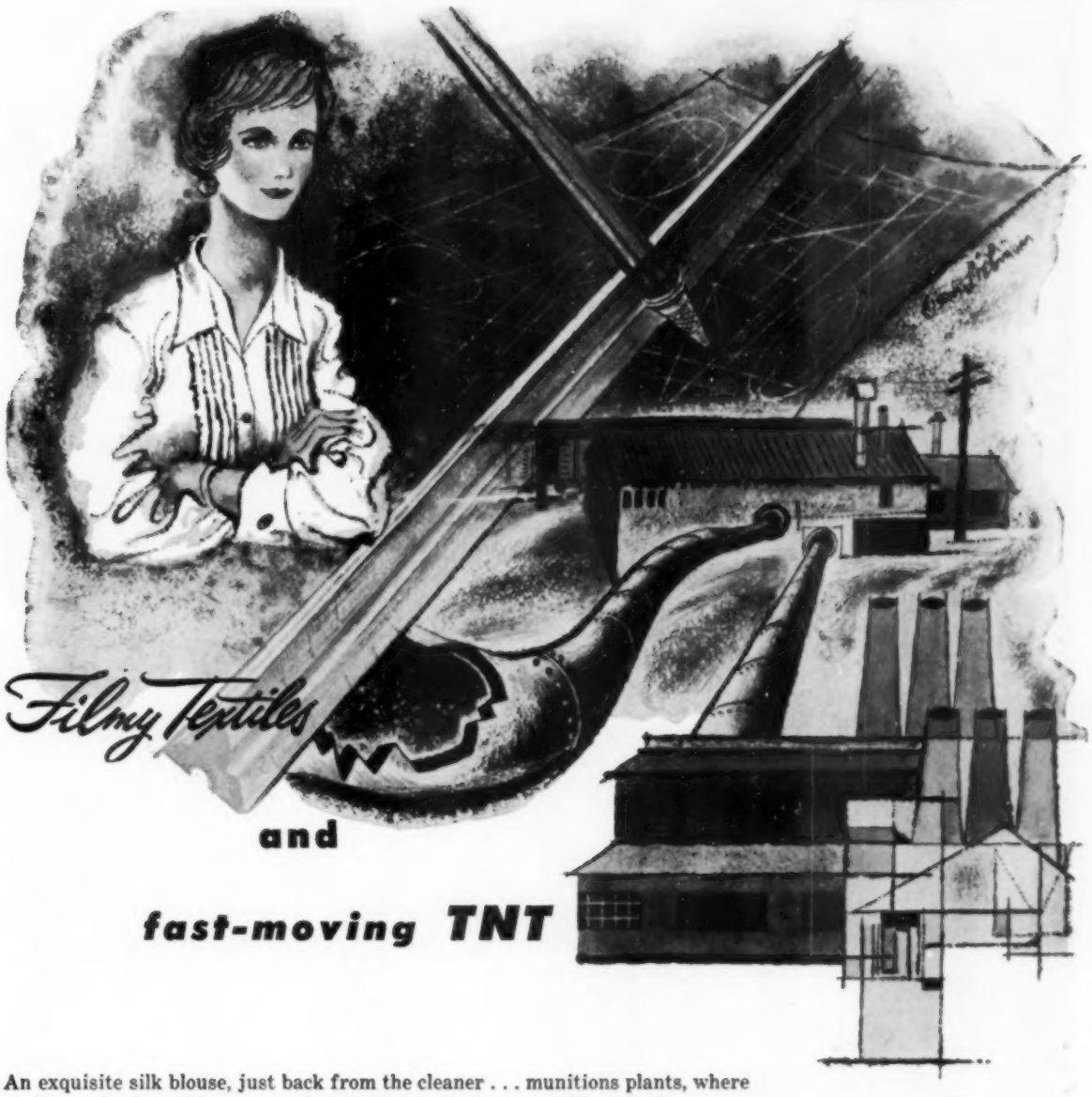

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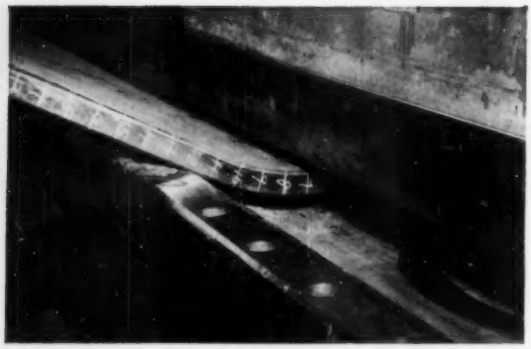

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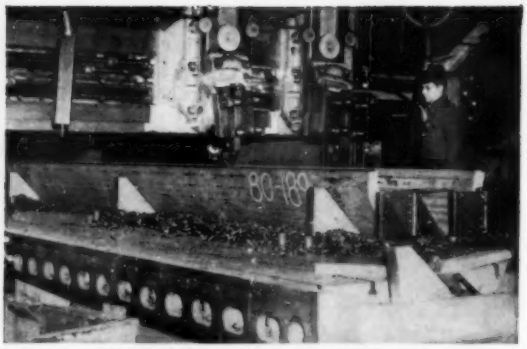

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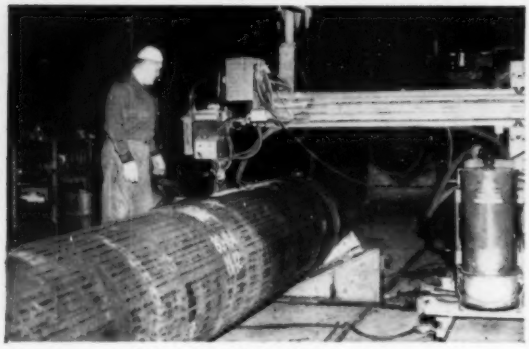

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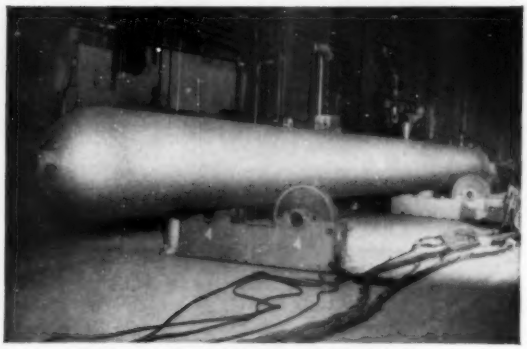

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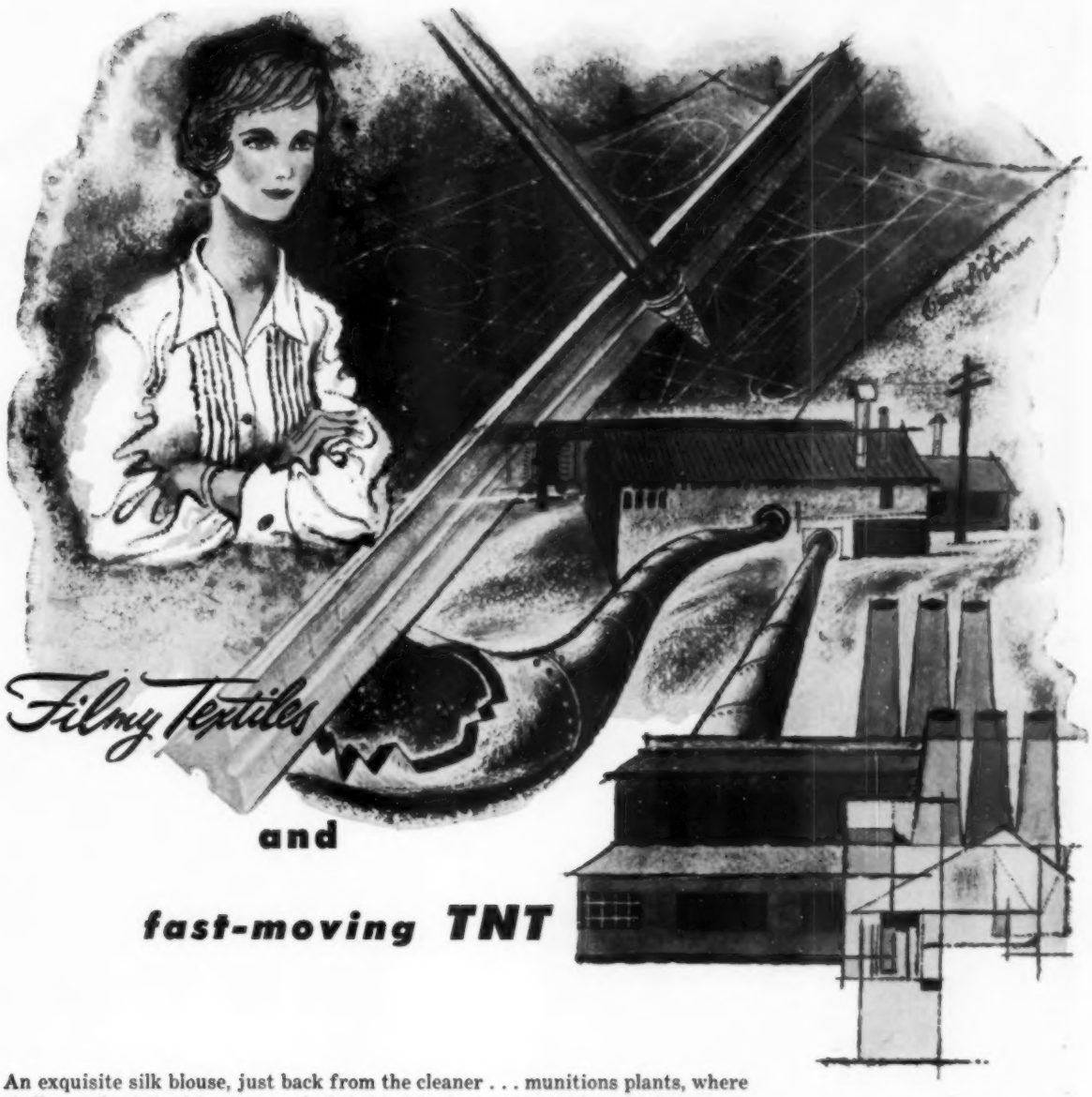

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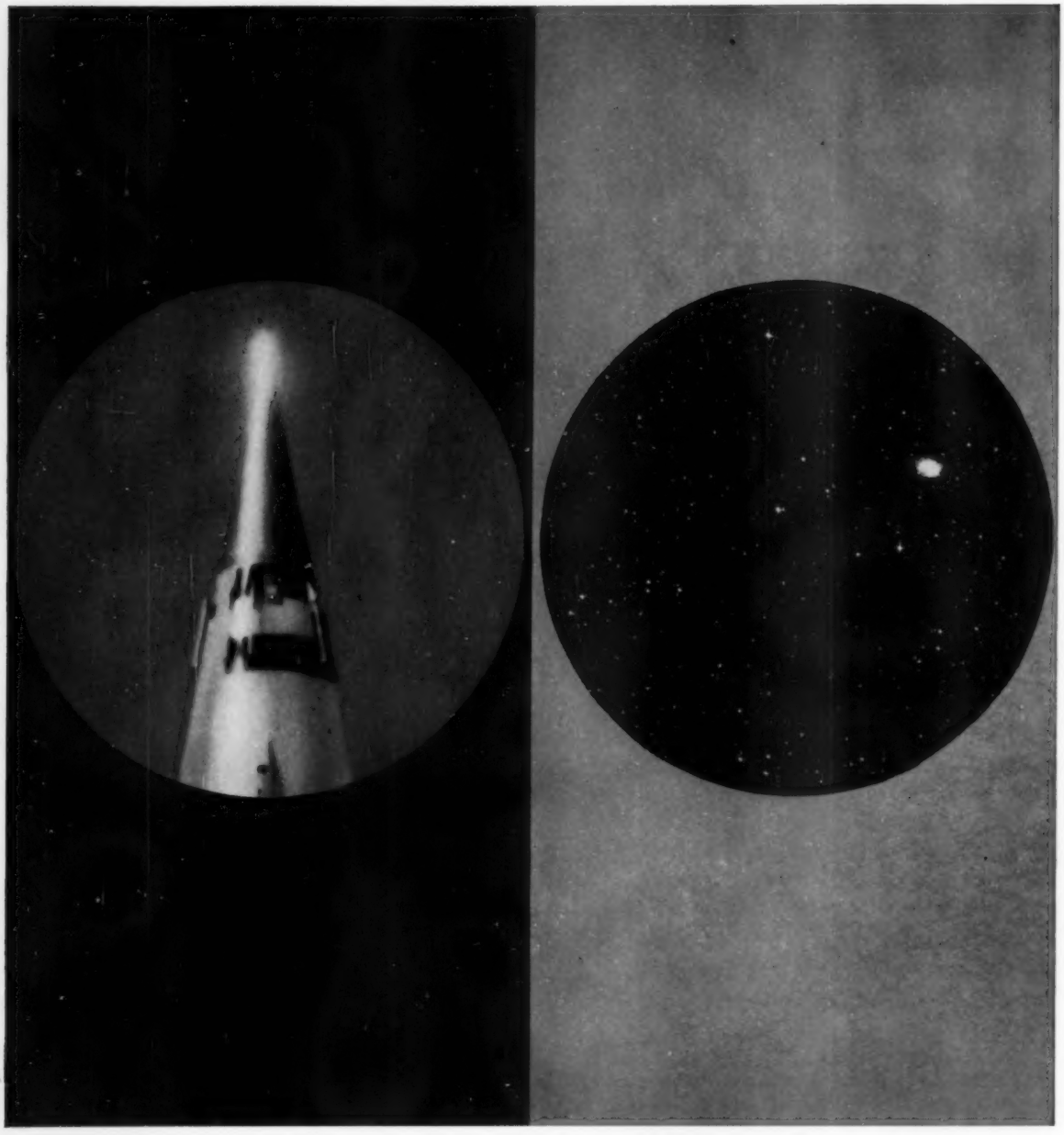

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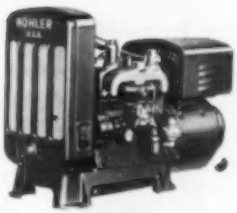

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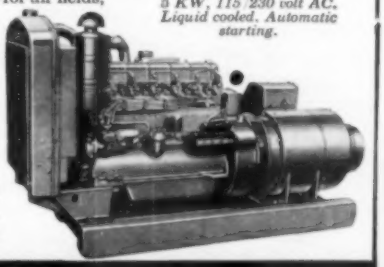

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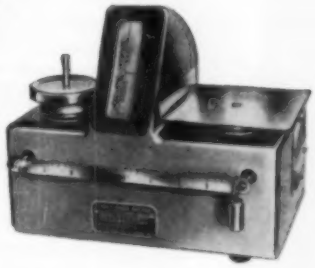

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ARMAMENT TECHNOLOGY

This section of ORDNANCE contains selected papers presented at meetings of Technical Divisions and Committees of the American Ordnance Association and contemporary articles on armament research, development, manufacture, and field use

Return of the Gatling

The multibarreled cannon gives us unrivaled aërial firepower

Lloyd Norman

Washington military affairs correspondent of the Chicago Tribune Press Service

LIEUT. Gen. Donald L. Putt, in charge of Air Force development, recently hailed the emergence of a new aircraft machine gun—what many ordnance experts believe may be the ultimate and the last of its kind in this era of rockets and guided missiles.

Speaking before the Aëro Club of Washington, General Putt told how the caliber .50 machine gun of World War II with a firing rate of 850 rounds a minute is being replaced with the 20-mm. cannon M39 that fires at the rate of 1,700 rounds a minute.

And this M39 gun, the general announced, will be replaced by a new 20-mm. gun with a rate of fire 6 to 8 times that of the old caliber .50 gun—or 5,100 to 7,000 rounds a minute. He said this amazing weapon—a giant killer of the sky—would enable a jet fighter to attack even when it cannot position itself properly for a clean shot.

THIS reference received little notice at the time. The daily press was more interested in the references to the big ballistic rockets, Atlas, Titan, and Thor.

But for ordnance experts and others interested in aircraft armament, the general had dropped a significant clue. It was obvious that, in this age of burgeoning rockets and missiles, the machine gun was not entirely dead. For about two years there had been rumors bruited around the Pentagon of a sensational new aircraft machine gun that fired so rapidly that it could be classified as a "supergun." This gun was being developed under "Project Vulcan"—a joint undertaking of the Air Force, Army Ordnance, and the General Electric Company at Schenectady, N. Y.

My records show that at the time GE said the gun had a "fantastically high" firing rate and that its 20-mm. shells were fed from the side through a long trough. I asked the Air Force at the time about the Vulcan machine gun and the Air Force press spokesman was cagey to the point of reticence. But he said that "it's not a gun—more like a firing mechanism." And he confirmed that it had an "exceptionally high rate of fire" and used the Gatling-gun principle.

LITTLE was heard of the Vulcan, named after the Roman mythological god of fire and metalworking, until a visit to Palmdale, Calif., where the Air Force has its production flight test center on the edge of the Mojave desert. Some 200 newsmen and other observers had come out to witness the first public flight of the Lockheed Starfighter F-104—world's fastest warplane with a potential speed of 1,500 miles an hour.

The lance-nosed "hotrod" Starfighter awed the crowd with its superfast climbs, snaprolls, and dives that made the Air Force's fast jets like the F-94, which escorted it on its flashy demon-

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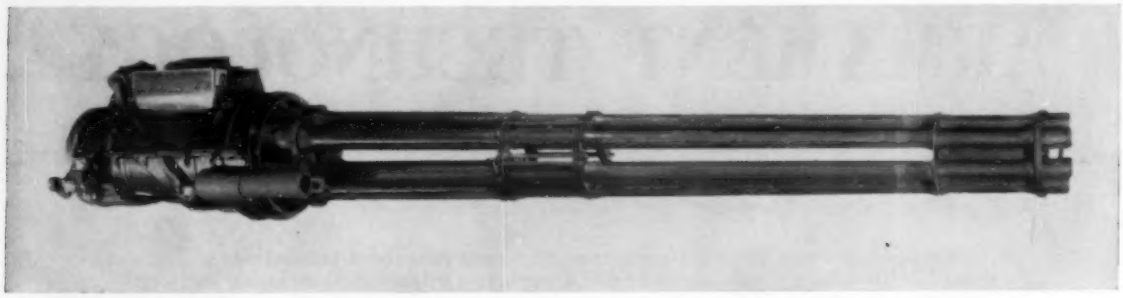
The caliber .30 1906 cartridge



Close-up view of the new six-barreled Gatling gun which may be installed in the supersonic F-104 (Defense photo).

stration look like an old Model T by comparison.

But there was something strange about the little F-104, and the observant newsmen lost no time staring at the curious bulge on the port side of the fuselage. They gathered in little knots around the F-104 model on the ground and debated about it.

"THAT must be the machine gun," one said as he approached closer and ran his fingers around the bulge. The others nodded silent agreement. The Air Force and Lockheed officials had said nothing about the new airplane's armament. They brushed off questions with the noncommittal remark that "it's still secret."

The newsmen generally agreed that there was room for a 20-mm. machine gun in that bulge, but it seemed that the diameter of the curve was too big for a 20-mm. I recall writing that the gun was a "still-secret 20-mm. cannon that pours out shells at the rate of 7,000 rounds a minute."

When I returned to the Pentagon several days later, I learned from General Putt's office that the Air Force could now confirm that it had in the final stages of development the new Vulcan machine gun.

This gun was expected to go into production late this year and would be installed in some of the Air Force's most advanced types of fighters. But the Air Force wouldn't confirm that the Vulcan was the new armament of the F-104. It was obvious, however, to those newsmen who had pawed over the F-104 that the bulge in its fuselage and the Vulcan went together like pork and beans. The F-104 was nothing without a deadly punch and the Vulcan probably was the best punch the Air Force had in the machine-gun department.

Since World War II the Air Force had been searching for a lightweight machine gun with a superhigh rate of fire and a high probability of destructiveness. The Air Force had tried out 27-mm., 37-mm., 75-mm., and 105-mm. guns but had discarded them as too heavy and with too slow a firing rate. Air Force ordnance experts wanted high muzzle velocity, long range, high volume of fire, and accuracy.

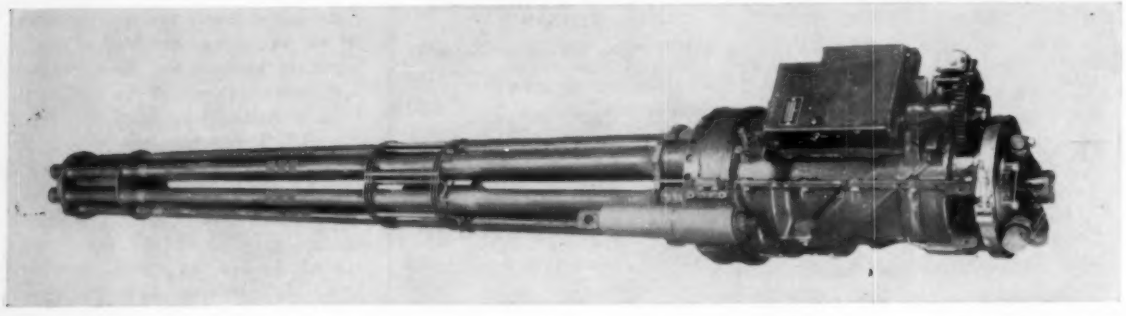
THE Reds apparently were well advanced in machine-gun development and had experimented with high-firing-rate mechanisms using the Mauser and Gatling principles. In fact, the Russian czarist government in 1871 had purchased quantities of Gatling guns from their inventor, Dr. Richard Jordan Gatling—and had them stamped with the name of the Russian General Gorloff—giving rise to the myth at the time that the Russians had invented the Gatling.

Soviet gun designers after World War II, however, did not follow the American predilection for high firing rates. The Reds favored simplified design, high reliability, heavier calibers, and slower rates of fire. Their aircraft machine guns generally were of the 23-mm. and 37-mm. type.

"IN the United States we will go to complicated mechanisms if this is necessary to get better performance," an ordnance expert said in commenting on this trend. "We wanted more potent weapons, which is reflected in higher firing rate, longer range, and a more lethal projectile."

The caliber .50 machine gun had been improved to a firing rate of 1,200 rounds a minute—about the maximum for reciprocating mechanisms of this caliber. The Air Force experimented with a caliber .60 and a 20-mm. machine gun. Then it tried the Mauser action discovered after the war in Germany by the United States, Soviet

Capable of firing 6,000 rounds a minute, the Gatling is a modernized version of an old idea (Defense photo).



Russia, Britain, and France. The Mauser used a revolver action with a single barrel permitting a much higher rate of fire.

BY 1953, near the end of the Korean war, the Air Force had a Mauser-action machine gun ready. It was called the 20-mm. gun M39 and eight F-86F jet fighters were equipped with the weapon.

The Sabrejets with the M39 went into action in MIG Alley against Soviet-built MIG-15's, each carrying one 37-mm. and two 23-mm. cannon. The American jets in the few days they were in combat destroyed 6 MIGS, probably destroyed 3 more, and damaged 12.

Air Force jet pilots and the test team headed by Maj. Raymond E. Evans of the Air Proving Ground Command reported they were delighted with the M39 and preferred the higher firing rate and smaller caliber of the 20-mm. rather than the Russian guns firing at a slower rate but with a heavier projectile.

The M39 is a 180-pound, 72-inch-long, electrically fired, gas-operated gun developed by the Army, Air Force, and the Ford Motor Company. It is in full production by the Pontiac Motor division of General Motors, with a second source in Chicago. The high firing rate is achieved in the M39 by a 5-chamber revolver-type cylinder which moves ammunition through the feeding, firing, and extracting phases at a much higher rate than a reciprocating bolt-type mechanism. The M39 is installed in the F-100, the B-57, and the F86H.

But even the Mauser action was not enough. Machine gun designers recognized the limitations of a single-barrel gun for high firing rates. The probability of a stoppage is greater in a single barrel.

LONG before any one dreamed of the 1,500-mile-an-hour speeds of upcoming jet fighters, Army Ordnance engineers were thinking of methods of getting higher firing rates from aircraft machine guns. Before the end of World War II, Col. René R. Studler, then chief of the Army's small-arms research and development, and his staff began to dabble with the idea of reviving the old Gatling-gun principle.

The Gatling had been dropped by the Army before World War I after it had been used since 1866. In 1893 Gatling had tried an electric motor drive to step up the rate to more than 3,000 rounds a minute. The old Gatling patented in 1862 is described as "one of the most remarkable firing mechanisms of all ordnance history" by Marine Corps Col. George M. Chinn in his book "The Machine Gun." The original weapon had six barrels for caliber .58 ammunition. It was later adapted for caliber .45, caliber .50, and 1-inch.

AS often happens in ordnance devolopments, no one in the small-arms research office now recalls who first thought of the idea of putting a motor on Dr. Gatling's gun for use as an aircraft cannon. Colonel Studler says that "maybe there were several who had the same idea." Anyway, Army Ordnance asked Johnson Automatics, Inc., to run tests on some old Gatling guns obtained from the Ordnance Museum at Aberdeen Proving Ground, Md.

It was in 1945 when an electric motor drive was attached to a .45-70 Gatling gun of the 1903 model to replace the old hand crank. This gun had 10 barrels. By 1946 the tests ran the firing rate up to the unheard of rate of 5,000 rounds a minute.

The new F-104 supersonic fighter climbs as fast as it flies level and may be armed with the Gatling (Air Force photo).

On January 18, 1946, the Army asked General Electric to undertake a development study of the Gatling principle for an improved fast-firing machine gun.

By June of that year General Electric was awarded a contract for preliminary design of a caliber .60 gun with a 60-inch-long barrel, a maximum gun length of 80 inches, and a minimum firing rate of 1,000 rounds per minute per barrel using 5 barrels.

The first design for the test gun was a 5-barrel model of medium size with the barrels grouped in a circle and fastened at the breech end to a single member plus additional support two feet forward, with the barrels tapering toward the end. The first model was completed and fired by April 1949, with a rate of 2,500 rounds a minute in short bursts.

From the start the Air Force was interested in the Army Ordnance project and provided the principal financial support for the rest of the development. The Navy was also interested for a time but later dropped out.

The General Electric tests established the feasibility of the Gatling aircraft machine gun. Improvements in the gun brought the firing rate to 5,000 rounds a minute by June 1950, and to 6,000 rounds by September 1950.

FOUR different models of the gun were tried at the Springfield Armory, Mass., and at Aberdeen Proving Ground. In May 1952, 7 of the guns fired a total of 75,000 rounds without a stoppage.

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>
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The three basic models of the Gatling aircraft gun by this time were the following:

	T45	*T150*	*T171*
Weight	365 lbs.	335 lbs.	365 lbs.
Caliber	.60	27-mm.	20-mm.
Length of round	6 ⅜ in.	6⅜ in.	6⅜ in.

TWENTY-SEVEN of the Model C or T171 guns were ordered with delivery starting in August 1952. The T45 and T150 were dropped as designs, and the decision was made to concentrate on the improved 6-barrel, 20-mm. T171 which had the most desirable features. It is 74 inches long, 5½ inches in diameter, and weighs about 250 to 300 pounds, complete with motors.

The Gatling can be driven by either electric or hydraulic motors to suit the preferences of the two manufacturers who will use the gun in their aircraft—Republic and Lockheed.

Mounted on a temporary base, the 20-mm. Gatling was shown at Edwards Air Force Base as part of an Armed Forces Day display.

The Gatling's operation is highly reliable. Like a 6-cylinder engine, it can keep working even if one of the barrels is stopped by a misfire. The barrels rotate counterclockwise. The ammunition is fed in at about the 5 o'clock position, fired at the 12 o'clock position, and ejected at the 6:30 o'clock position.

The 20-mm. ammunition is belt-fed in the advanced model T171 and may use a linkless feed in its own drum container on a conveyor-type endless belt.

Pilot production of the Gatling Vulcan gun started at the General Electric plant at Schenectady two years ago. Improvements are still being made in the gun before the design is finally "frozen" for full production sometime later this year.

The Air Force is not expected to announce what aircraft will use the Gatling Vulcan gun until the jet fighters are in combat units. But in a few months when more and more of the F-104 Lockheed Starfighters appear with the tell-tale bulge it will be apparent that the Vulcan sky gun is the F-104's lethal weapon. Any enemy aircraft that comes within a mile of the F-104 will have little chance to escape the burst of hundreds of 20-mm. explosive shells.

The stubby little F-104 with its knife-edge wings each 7½ feet long will also be able to carry rockets, missiles, or even atomic bombs, according to Lockheed officials. It is believed that the 2-seater version of the Starfighter, the F-104B, which could be used as an interceptor, also could mount the Vulcan gun.

THE Starfighter can be equipped for various types of combat missions with plugged-in "black boxes" of electronic communications, navigation, or aiming devices.

The dazzling speed of the F-104 is derived from its powerful General Electric J-79 jet engine reportedly rated at 15,000 pounds' thrust or about 60,000 horsepower at the top speed of the aircraft.

The little F-104 weighs half of the standard 25,000-pound fighter. It was designed for the highest possible speed and firepower per pound of weight.

Because of its design for maximum simplicity and fast mass production, the bantam fighter costs only about half the price of a standard fighter, according to Lockheed officials.

Ball Powder

The spherically grained propellant has proved practically nonerosive in machine-gun ammunition and can be manufactured economically and quickly with the uncomplicated equipment used in chemical plants

J. J. O'Neill

IN excess of 40,000,000 pounds of ball propellant loaded in over 10 billion rounds of small-arms ammunition were produced before it was discovered that this new type propellant has one of the most unique and valuable properties ever found in a propellant. Samples of the ball propellant submitted to Aberdeen Proving Ground for ballistic evaluation in the caliber .50 round were found to be practically nonerosive in machine guns when compared with the erosiveness of the conventional extruded propellant.

This discovery, which was not anticipated by Ordnance personnel or by the developer, the explosives division of Olin Mathieson Chemical Corporation, seems to be the answer to the machine gun designer's prayer. Repeated tests in caliber .50 and other large-caliber aircraft machine guns have proved the discovery to be real and not just a freak characteristic in the original test lot. This discovery, plus other previous known advantages of ball propellant, resulted in the undertaking of intensive research and development programs by Olin Mathieson and the Ordnance Corps to meet the specifications for other calibers, such as caliber .60, 20-mm., 27-mm., and 30-mm.

AS a result of the Aberdeen discovery and its other commendable characteristics, ball propellant has been adopted as an alternative propellant for caliber .50 and the preferred propellant for caliber .30 ammunition. It had previously been established during World War II as an approved propellant for the caliber .30 carbine, and almost all the carbine ammunition produced contained ball propellant.

Mr. O'Neill is assistant general manager, explosives division, Olin Mathieson Chemical Corporation, East Alton, Ill., and chairman of the Ordnance Association's Propellants and Explosives Committee.

What seems to be the reason for this outstanding difference is still somewhat of a mystery. None of the several hypotheses has been studied in sufficient detail to draw firm conclusions as to the exact mechanism. The basic difference is, of course, well understood and results from the difference in manufacturing processes by which the discrete grains of propellant are formed as compared with conventional extruded propellant.

The latter type is modified to adjust ballistic properties by changing the size and shape of the grain. The resulting variations in available surface area on which burning may proceed and in the web (thickness) through which the propellant must be consumed combine to change the burning properties of the propellant to meet the ballistic requirements.

Further, the web is generally varied by changing the size of the perforation, and, since the grain burns from all available surfaces, the increase of the surface area of the perforation during burning exactly equals the decrease in area of the outer surface. This compensating effect permits the gas to be evolved substantially uniformly throughout the entire burning process.

In the ball propellant process the grained product is spherical—a most undesirable shape in the opinion of leading ballisticians until the ball propellant process proved this type successful. As can be readily visualized, the area available for gas production on a burning ball propellant grain diminishes as the burning proceeds.

THEORETICALLY, this is undesirable because the point of greatest gas production is at the instant of ignition before the inertia of the projectile has been overcome. Such conditions lead to high internal gun pressures, and at normal charge weights— *i.e.*, with the propellant charge required to impart the necessary energy to the projectile —the gun would rupture due to the excess pressure.

Dr. Fred Olsen, the inventor of ball propellant, and now vice-president for research, Olin Mathieson Chemical Corporation, would not concede the point with his contemporary ballisticians.

He reasoned that this spherical product, which was considered by many to be a useless form for propellant could be made useful ballistically if the outer

surface of the sphere could be substantially modified with a nonburning or slow-burning material The presence of such a material would retard initial burning so that bullet inertia could be overcome before high pressures developed.

This theory proved to be correct and a new type of propellant was developed.

Dr. Olsen conceived of the process of stabilizing nitrocellulose by gelatinizing it with water-immiscible solvent. This destroyed the fibrous nature of the nitrocellulose which was known to hold tenaciously the deleterious acids from the nitration process. The intimate association of the gelatinized nitrocellulose and water completed the stabilization. The water served to wash away and neutralize the objectionable acid.

Next, he reasoned that with controlled colloidal techniques the gelatinized nitrocellulose could be formed into spherical droplets from which the solvent could be distilled to form hornlike nitrocellulose spheres.

The use of chemical control of the ballistic properties of the grain rather than control of the physical properties was used throughout World War II in propellants for the caliber .30 carbine, British .303, Chinese 7.92-mm., .30-06, and other small-arms loads. Strangely enough, at that time no one noticed that ball propellant ammunition was not eroding gun barrels as rapidly as the extruded form. The chemically modified propellant has just about the same energy level as extruded propellant and consequently has about the same average temperature.

HOWEVER, unlike the extruded grain, which has less chemical modification of the surface and therefore a generally more constant flame temperature, the ball propellant has a very low initial flame temperature which increases throughout the burning cycle, reaching a maximun at the end of burning.

Apparently this lower temperature in the initial ignition stage, coinciding with the maximum gun barrel pressure, practically eliminates erosion at the breech in standard machine-gun barrels.

Like extruded propellant, ball propellant is made from nitrocellulose. However, because the ball grain forming operation is at the same time a stabilizing process, the nitrocellulose need not be purified to the same degree as the nitrocellulose for extrusion which undergoes no further stabilization during the graining operation.

Workman examines interior of the glazing barrel used in making ball powder.

As a consequence, much of the costly nitrocellulose stabilization may be eliminated, and there is no limit to the rework possibilities. Propellant of all degrees of stabilization or deterioration may be salvaged through ball propellant stabilization where previously this otherwise valuable material was destroyed.

One of the very interesting features about the composition of ball propellant is that in most instances the product is a "double-base" rather than a "single-base" propellant. This means simply that, in addition to the nitrocellulose, it contains another high-energy ingredient which gives added power to the propellant. It has become almost generally recognized that the term "double-base propellant" refers to those containing nitroglycerine in addition to nitrocellulose.

Since nitroglycerine is a much hotter burning chemical than nitrocellulose, this type of propellant was more or less prohibited for military use in this country. The thought was that the hotter burning material would cause excessive barrel erosion and flash.

It has, therefore, been a point of added interest that despite the fact that ball propellant is a double-base propellant containing nitroglycerine it has turned out to be the least erosive small-arms propellant yet developed.

The familiar hydraulic presses and huge solvent-recovery system of the extruded propellant process are not needed in the much simpler, much safer to operate, ball propellant plant. In fact, for the most part, the processing equipment is nothing more complicated than the tanks and piping familiar in any chemical plant.

The solution of the nitrocellulose, the stabilization, the grain forming, and the solvent removal all take place in one uncomplicated vessel—an agitated tank containing a heating jacket and equipped with a water-cooled condenser for solvent recovery. In addition, there is no need to dehydrate the nitrocellulose, and it is used water-wet as it comes from the nitration plant.

The practice followed is to prepare still charges, usually 3,000 pounds of nitrocellulose, in a make-ready tank which may be an agitated wooden vat or a concrete pit from which it is pumped to the still. More water is then added to make a free-flowing slurry.

ETHYL acetate which is an excellent solvent for nitrocellulose (and is practically water immiscible) is now pumped to the still. This solvent dissolves the nitrocellulose, converting it into a doughlike mass which is suspended in the water phase by the agitator.

The complete solution of the nitrocellulose destroys the fibers and releases the absorbed acids retained from the nitration to effect the most complete stabilization known. The material is stabilized against further rapid deterioration by the use of diphenylamine which is added as a solution in the ethyl acetate.

When solution is complete, which is within one hour after the solvent is added, a gluelike material known as protective colloid is added to the still. Protective colloids such as animal glue and gum arabic have the ability to surround a material suspended in water, forming a protective coating which prevents a combining of individual bits of the suspended material to form a larger mass.

Therefore, as the agitation continues and strings of lacquer are broken off

the main body of the doughlike mass they are coated by the glue and cannot recombine. Hence, after a short period of agitation the one large ball of dough is reduced to millions of tiny globules, some smaller than the head of a pin.

EACH tiny globule exists as an entity because the glue prevents it from combining with its neighbor. Thus, use of these protective colloids takes advantage of a physicochemical phenomenon best known in the emulsion-forming processes.

Relying on another physicochemical phenomenon, the globules of lacquer are soon converted, due to surface tension, to perfect tiny spheres. This is the same phenomenon which causes mercury to form spheres when dropped onto a surface.

The "grained" propellant is at this point soft and "gooey" because of its solvent content. Solvent removal is accomplished by increasing the temperature of the still to the boiling point of the ethyl acetate, boiling it off and recovering it by condensation. Only a few hours are required for complete solvent removal by this process.

This is an added advantage, because extruded propellant must be treated over a period of from several days to several weeks to accomplish the solvent removal without destroying the grain shape by warping. Further, the closed system allows practically one hundred per cent recovery, whereas in the extruded process the solvent lost is very high by comparison.

At this point two basically different products could be produced—one a very dense, hard sphere which is generally needed in rifle ammunition, or a very low grain density, porous product which is used in shotshell ammunition or blank fire loads. The low-density product results from the process outlined above; the high-density product is obtained merely by adding a salt such as sodium sulfate or even common table salt to the water phase before the solvent is removed.

WHILE this is a simple process change, the resulting physicochemical difference is tremendous. The presence of the salt in the water in which the grains are suspended causes water emulsified within the globules to be withdrawn thus densifying the grain.

The product from the above operation usually contains grains of varying diameter from about 0.006-inch to about 0.030-inch. Knowing the tremendous effect that grain geometry has on ballistics, it is apparent that grains of such widely different size would create difficult ballistic problems. This product is, therefore, separated into closer-size "cuts" by passing the propellant through a rotating screen operating under water.

Screen sizes are selected so that the propellant is separated into charges containing grains from 0.004-inch to 0.009-inch difference. For example, the propellant used in one of the caliber .30 loads contains a grain size separation of 0.025 to 0.020-inch.

The next step is to adjust the burning rate of the separated propellant by applying a deterrent to retard the initial burning. Usually nitroglycerine is added to the ball grains in the same operation in order to raise the energy level of the material to compensate for the lowered energy affected by the surface deterrent.

In both the nitroglycerine and deterrent addition, these materials are added to the water in which the propellant is suspended by agitation. The propellant has an attraction for these materials and absorbs it from the water. The equipment needed is again just an agitated tank like the grain-forming tank.

However, since the large quantity of solvents needed for the grain-forming operation is not needed in the coating operations, much larger propellant charges can be used. These are usually in the order of 12,000 to 15,000 pounds.

After coating, the propellant is pumped to a filter, separated from the water, and dried. Subsequent operation of graphite glazing, dry screening, and blending are conventional.

JUST following the coating operation there is another optional step which is being used to great advantage as it improves the ballistic qualities of the propellant in many ammunition rounds. This is a "rolling" operation in which the propellant is passed through two revolving rolls squeezing it from the spherical shape to a disklike shape. The rolled propellant is then processed as is the unrolled propellant.

The rolled grains have improved performance in some rounds because the disks all have the same web—hence all the propellant charge burns out at the same time leaving no longer-burning grains to ignite the muzzle gases to form a flash in loads where there is a flashing tendency. Rolling to produce one size of grain makes for a more efficient use of the propellant and usually permits a smaller charge to produce the same velocity.

Ball powder in the making is discharged from the continuous infrared drier.

Applications Engineering

It is the task of the office of the Assistant Secretary of Defense, Applications Engineering, to see that the greatest development effort is expanded on potentially major rather than minor advances

S. S. Podnos

TWO of the more important responsibilities assigned to the Assistant Secretary of Defense for Applications Engineering are, first, to assure that new military weapons and equipment are suitable for production and service use; and secondly, that minimum kinds of these weapons and equipment are attained. A discussion of these will serve to point up a considerable portion of the Applications Engineering rôle.

The office of the Assistant Secretary of Defense (Applications Engineering) was created by adoption of the Defense Department Reorganization Plan of June 30, 1953. This plan included the first official and practical recognition of the importance of engineering experience and methods in the work of the Department of Defense. In effect we operate as the engineering staff of the Secretary of Defense and within this field advise the Secretary, components of his office, and the military departments on engineering situations and problems without limitation.

THE assurance of suitability for production and use is a difficult responsibility. Billions of dollars' worth of military matériel has been and is being mass-produced which is not ready for production. To reduce the extent of this practice we are attempting to arrive at an orderly method for planning, executing, and introducing project items into inventory and use.

Toward achieving an orderly transition from research through inventory and use, let us consider the normal procedure through which a project for the introduction of a new weapon or equipment should pass. We need to examine this procedure closely.

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AFTER basic research, which reveals new knowledge, comes development. This development is a 2-horned animal. The first horn is that of exploratory development, which can also be called applied research. This is the phase wherein new knowledge is first applied. It should culminate in a determination of feasibility—by experimental models, paper studies, and the like—followed by an evaluation of the approaches selected, a selection, and an authorization to proceed, if forthcoming.

The second horn of the developmental animal is one in which application is made, based upon the specification laid down and approved at the completion of the feasibility phase. This application is directed toward a design suitable for production and use to satisfy an operational need. This design-development phase is of the engineering type and is the first step of Applications Engineering.

Exploratory development projects may be initiated for two purposes: first, as a part of forward planning to determine feasibility of a new principle but with no immediate planning for reducing the new idea to practice; and, secondly, as an integral part of a project whose current objective is the design of a weapon or component suitable for service use.

It is necessary to consider the results of exploratory development of the second kind when initiating design development. In this case, Applications Engineering review of a project necessarily includes the exploratory phase.

NOW let us consider the two horns in more detail. Prior to exploratory development the military services draw up military characteristics (or in the Navy, operational requirements) which describe the desired performance and intended application of the new device or system.

All too often these are drawn up in the manner that the equipment itself is described in detail in addition to the job to be done. In many cases this is necessary. However, when unnecessary, this procedure only serves to stifle crea-

tive thinking. In most cases it should be sufficient to state "what is needed" without defining how it should be accomplished.

Following this statement of operational need, many different approaches could profitably be explored. When these multiple approaches have been suitably subjected to feasibility determination and evaluated, not only against each other but also against what is already in the system, decision can be made based upon both merit and cost to pursue one approach (or at most two) into application, or cancel the project. It may be desirable to evolve a piece of equipment meeting ninety-five per cent of the operational need rather than all of the need if the cost can be cut in half by so doing.

BUT what needs emphasizing is that this is the normal point to weed out and select, for this is the point past which large expenditures are necessary. The selection process should be accompanied by detailed characteristics; that is, how something should be done as embodied in a piece of equipment together with a plan of development covering the engineering phase of the project.

The selection of a suitable approach from the exploratory work, to be carried through into engineering, often involves tough decisions. It means stopping some things. This is hard to do in this kind of work. It is not overly expensive to have multiple approaches in exploratory work. In fact, in terms of pay-off it can be very worthwhile.

In the engineering phase, however, costs rise rapidly because hardware is being built for the many tests required. It is, therefore, of great importance to narrow down the field as early as possible and before the engineering phase has gone very far.

THE engineering phase should be one wherein the design is developed (we call this design development) to meet military characteristics or operational requirements laid down as a result of the exploratory development phase. A series of engineering tests is usually required, the last of which demonstrates compliance. However, the design is not yet ready for production unless proper production engineering has accompanied the design development. If this has not been done, it must be phased in at this point.

I HAVE emphasized the dual activity covered by the term "development" because failure to distinguish them has caused confusion in project planning. When the term "research and development" is used, many interpret the term as covering solely exploratory work. Actually the "development" part of the term consists largely of the applications phase directed to the design of something to be made or used.

The distinction is also important for another reason. When the two development horns are not properly identified, there is a strong tendency for the multiple approaches of the exploratory phase to carry on as multiple projects in the engineering phase and then as multiple items in production for inventory and use.

Production engineering includes the preparation of final drawings and specifications not only for the design but also for the tooling to produce it. After this phase, based upon models made to final drawings and specifications, the item should be subjected to service test (Army), operational evaluation (Navy), or operational suitability test (Air Force). It should be noted that this procedure will give the user for test something closely representative of what will come from production, which is so often not the case today.

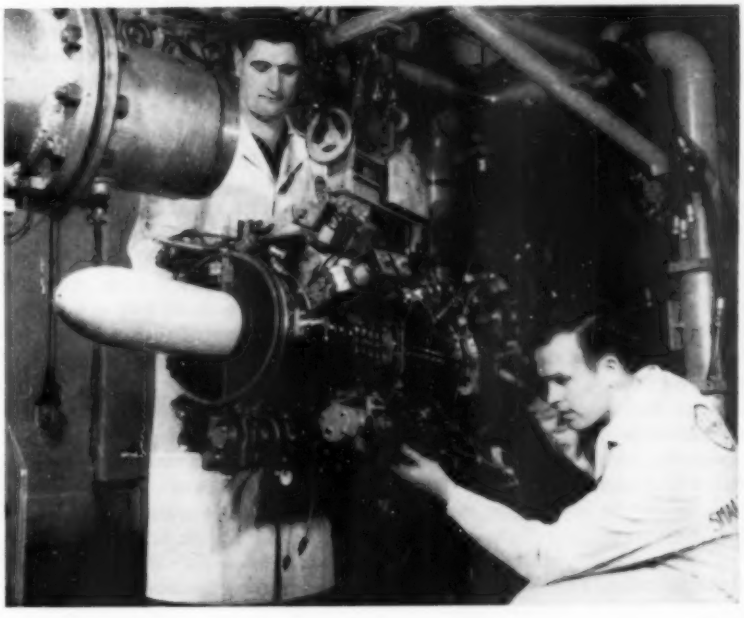
Another shortcoming here is that the user evaluation agencies are customarily staffed with superior personnel used to the test procedure. It might be well to subject most items to a parallel test by a selected user group not devoted to evaluation. In other words, determine whether or not the item is soldier-proof. Joint acceptance by these should lead to type classification based upon obtained characteristics or, in other words, a standard item approved for service use.

Upon type classification, production should proceed, preferably at the industrial facility which was assigned the engineering phases. This will retain background knowledge and experience for use in production.

ONE of the steps taken by our office toward encouraging this practice is embodied in Defense Department Directive 4105.10, issued in 1955, whereby the policy of awarding initial production contracts to the contractor who developed a new device, and not necessarily to the lowest bidder, is clarified and amplified.

This should assist those industrial organizations interested in the develop-

This small T58 gas turbine engine being developed by General Electric is expected to reduce helicopter operating costs and maintenance and allow heavier payloads.



ment and production of complex engineering military products. Further, the industrial facility which conducted the engineering phases should probably be the only one to mass produce the item initially until all normal production-run "bugs" are eliminated. Then, using this facility as the mother of the item, the production base may be broadened, if desirable, by selection of other facilities.

The superimposing of orderly phases in a disorderly manner without good engineering judgment results in the so-called "crash" program which has and is bought so frequently on the basis of saving time. Time has seldom been gained.

The mass-production of unready matériel under "crash" procedure creates the situation where both the service technical and user agencies say an item is not satisfactory; yet production proceeds as if it were.

THE tendency to "crash" a project imposes too severe a penalty on both our industrial resources and our military ability to use and maintain. The long-range pull we are in currently lends very little justification to the "crash" program.

The procedure I have outlined is perhaps an oversimplification. It can be filled in and continued to a considerable degree. It will also vary for specific types of items, notably those that are large and complex and those that are produced by the millions. But in every case the basic intent of using an orderly method to achieve suitability for production and service use is not changed. It is the aim of our office to reduce the procurement of development-type items to the minimum level required for development and test.

THE attainment of minimum kinds of weapons and equipment requires a different type of thinking than the suitability process just discussed. Here, too, we must plan, execute, and introduce. However, the suitability process is on a project level. The attainment of minimum kinds of weapons and equipment, on the other hand, is on a technical program level where many projects may be involved in each program.

The Department of Defense spends about $2 billion each year for the engineering development and test of new weapons and equipment for the service use of our armed forces. It is the job of all of us to see that these funds are expended economically and efficiently. It is necessary that what these programs are, where they are heading, and whether they will serve their purpose when they get there be scrutinized technically by the Office of the Secretary of Defense. We must also assure ourselves that the larger part of the over-all development effort is being fed into potentially major rather than marginal advances. The Office of the Assistant Secretary of Defense (Applications Engineering) is doing and will continue to do this.

We expect, with the coöperation of the military services, progressively to prevent unnecessary duplication of engineering development work to arrive at, in effect, one Department of Defense program in each area of technical activity common to more than one service. In other words, we believe that the sum of one plus one plus one can, and should, be less than three.

As an example, more than two dozen different types of armament are under development by the Navy and Air Force for use in an air-to-air rôle. Only an extremely small number of these are currently planned for possible use by both services, even though the targets presented will probably be the same.

FURTHER, almost all of the more than two dozen different types—based upon service-provided data—are expected to be made available within a 4-year span. This can only lead one to suspect, at best, that the technical program planning in this area is deficient and that many of the weapons must represent only marginal advances or outright duplication.

We expect a review of this situation to lead to a smaller number of different weapons without loss of military effectiveness or readiness and with the well-known advantages of standardization and simplification.

To achieve a reduction in types requires that the military development program be based on more long-term planning. In other words, where does a new project fit programwise? It is necessary to take a longer look ahead, at least to determine the characteristics required in the generation of equipment to succeed the generation now under development.

It is sensible to slow down the development of marginal types in favor of a more concentrated effort upon major advances. We do not have the resources to do both competently. The strongest defense will result in our cencentration of resources on a smaller number of the most important projects.

FISCALLY, we review and approve, in collaboration with the Office of the Assistant Secretary of Defense (Research and Development), development projects funded by research and development moneys. Independently, we review and approve development projects funded by procurement and production moneys, excluding those projects already approved for service use. This procurement and production review and approval also covers any reprogramming activity during the year.

Since the larger part of the development dollar prior to approval for use comes from procurement and production funds, our task is an important one. We are attempting through the better planning and execution of projects and programs to get the most for the defense dollar. Fiscal reviews, based upon technical considerations, make this goal easier to attain.

Most of our day-by-day activities are in the field I have discussed, which may be described as the technical review and approval of projects planned for the development of weapons for service use. This work, however, has an indirect objective. It is "grist for the mill" for our basic job of establishing better policies and procedures to accomplish these ends—to base new projects on the right planning principles.

DURING the last few months, some of our efforts have been reflected in the issuance of basic Department of Defense policies and procedures. We are a relatively new organization and as we acquire background, based upon fact, more of our efforts shall be so reflected.

There has been a significant change in attitude toward the importance of good planning and management in development and procurement activities, including cost and time factors, and much also has been accomplished to improve coördination among the services.

Fifty Years of Firepower

For half a century the caliber .30 cartridge, 1906 Model, has been the "old reliable" round for the small arms of our Nation's forces, and continuing improvements have kept it a powerful defense factor

Col. B. R. Lewis

THE cartridge known throughout the world as the United States caliber .30 Model of 1906, though adopted fifty years ago, is still recognized as one of the finest for military use. In the United States it has been the standard large-bore cartridge for sportsmen, and shooters have based many "wildcat" variants upon its excellent components.

This happy combination of good qualities did not just happen. It was the result of many years of search, experiment, and manufacturing refinements. On the occasion of its fiftieth birthday, a résumé of its history is in order.

Our search for a caliber .30 rifle and ammunition really began back in 1890, when both rimmed and rimless cartridges were developed for testing rifles submitted to the Ordnance Board. No satisfactory smokeless powder was then being made in this country, so foreign propellants were used.

WHEN the caliber .30 Krag rifle and carbine were introduced in 1892, their rimmed .30-40 Krag ammunition (sometimes called .30 USA) used a round-nosed 220-grain bullet with cupronickel jacket, fulminate primer, and Peyton powder. This double-base smokeless powder with green hexagonal grains was made by the California Powder Works. The cases were tinned inside and out to prevent corrosion.

In 1898 we started to use our first chlorate primer, known as the H48, and a single-base nitrocellulose powder made by Laflin and Rand. This "W. A." powder was named for Whistler and Aspinwall who were pioneers in small-arms smokeless powder and continued in use until 1908.

Colonel Lewis is a well-known weapons historian and an expert in the field of small arms. His distinguished book on U. S. small arms and ammunition has just been published by the Smithsonian Institution. Colonel Lewis is special assistant to the Ammunition Group, Frankford Arsenal, Philadelphia, Pa.

Also in 1898, a joint board recommended that we seek a new clip-loaded rifle, having a barrel of intermediate length, to replace both rifle and carbine. A velocity of 2,500 feet a second was asked for. That is where the .30-06 started.

First a rimless Krag round was tried but its short case would not hold enough powder for the required velocity. A longer case was made, still using the 220-grain Krag bullet with round nose, and the "W.A." powder. This powder had about 30 per cent nitroglycerine and burned very "hot." Barrel life was too short, so velocity had to be reduced.

By the time the new rifle design was ready in 1903, the cartridge for it—considering the short barrel, hot powder, and heavy bullet—gave only 2,000 foot-seconds' velocity. A new, short, pointed bullet was tried, the German "spitzer" type, weighing only 150 grains. For its reduced bearing the cartridge neck was shortened a little.

This produced the Model 1906 cartridge (Fig. 2). Velocity was 2,700 foot-seconds, but barrel life was still short. Since then its history has been one of component improvement—primer, powder, bullet, and case—and process evolution and refinement.

UNDER an Act of March 2, 1907, rifles chambered for the M1906 cartridge were supplied to the militias of the several States and territories. This was completed by 1908. But complaints began to come in concerning excessive metal fouling in the barrels. Springfield started to lap the barrels—the smoother surface helped, but the fouling was still bad. Various fouling remover solutions were tried with some success.

But a new Du Pont powder offered the best chance for improvement. About the same as the "HiVel" later made by Hercules, it was known as "1908 Military." In 1907 construction of an Army powder factory had begun at Picatinny Arsenal, following Maj. B. W. Dunn's designs. Maj. Odus C. Horney was in charge of the construction and initial operation. Beginning in 1909, 250 pounds of small-arms powder were produced per day.

That year another new propellent

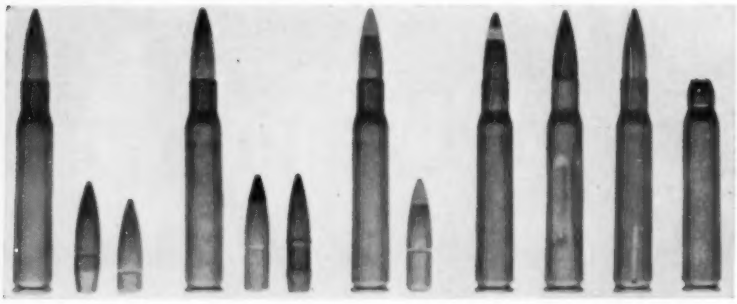


Fig. 1. Caliber .30 cartridges, 1925-1956, left to right: Ball M1 and bullets M1 and M2; AP M2 with M1 and M2 bullets; tracer M25 with bullet; frangible; dummy; range dummy M1921; blank, grenade, M3.

powder became available, Du Pont's "Pyro D.G." This was a straight nitrocellulose powder containing diphenylamine and graphite. It had a black tubular perforated grain. As MR1909 it was the standard powder through World War I. But the original load had already attained fame. The Olympic shoot in 1908 was won by the United States team using the new M1906 ammunition.

IN 1909, the Winchester Repeating Arms Company, the Union Metallic Cartridge Company, and the United States Cartridge Company were each given contracts for one million rounds of ball ammunition to be tested competitively for use in the National Matches at Camp Perry. This system was continued for many years.

That first time the ammunition made at Frankford Arsenal was second best, a spot it occupied until 1925. Then it captured first and held it while the competitions continued. All competitors made very fine ammunition.

In 1910 a new primer, FA No. 42, was adopted and stayed in use until June 1917. It differed from former compositions in omitting ground glass. This, with better propellant, further reduced the fouling difficulties and improved accuracy. The mean target radius of all ammunition made at Frankford in 1909 had been 4.87 inches at 500 yards. By 1911 it had been reduced to 3.92 inches.

The National Matches served as a testing area for continued improvement. Minor changes were made from time to time. After the first few years, the case mouth was crimped onto the bullet to avoid accidental displacement. This was especially significant in machine guns, where a sharp bump on the point of the bullet could push it back into the case. During World War I, the primer was crimped in to meet other requirements of machine guns. One gun, the Marlin, needed a specially heavy ring crimp to hold the primer, as its breechblock gave but little support to the cartridge head.

Soon after our troops arrived in France there were complaints about bad primers. Investigation showed that the FA42 composition was deteriorating. Before the war we bought our potassium chlorate in Germany, but after 1916 we used material derived from Chilean saltpeter. This contained small amounts of bromides, which reacted with the sulphur in the primers to form acid.

We switched to a commercial primer, the Winchester NF35, for one year. In that primer, the sulphur of older compositions was replaced by TNT and lead compounds. Then in June 1918, the FA88 primer was used. This resembled the Winchester type except that tetryl took the place of TNT.

This composition was used for three months, then FA70 was standardized, which was just the same as NF35. This composition is still in use and has proved very reliable.

DURING World War I the A.E.F. found that rifle-caliber ammunition used by both France and Germany far outranged that used by American troops. Ordnance was asked to produce a cartridge that would have an effective range of 3,800 yards and a flat trajectory. Spark photographs and other experiments at Frankford Arsenal in 1921 established the fact that the velocity of sound is a critical factor in the shock wave formed by a bullet's flight. These investigations provided sufficient information so that an effective boattail design could be made.

After extensive development the M1 bullet was adopted in 1925 (Fig. 1). That 173-grain gilding-metal-jacketed bullet had the optimum 6-degree boattail. Because of manufacturing difficulties, however, the angle was later changed to 9 degrees.

Meanwhile Du Pont had introduced a new powder, No. 1147, the first of their "IMR" series. This contained a small amount of metallic tin, which eliminated most of the metal fouling.

By 1938 the requirement for long-range caliber .30 machine gun fire was gone, so to save material and reduce recoil, the M2 bullet was put into service. This is essentially the same as the original 150-grain bullet except for its gilding-metal jacket. With the gilding-metal bullet, tin was no longer needed in the powder, and a further improved IMR powder having tubular grains coated with DNT, was used.

WITH the combination of this IMR 1185 powder and the gilding-metal bullet jacket, the maximum pressure was reduced from 48,000 to 45,000 pounds, producing 2,700 foot-seconds of muzzle velocity with less flash. From February 1941 to September 1942, IMR 4676 was used. Ordnance adopted IMR 4895 in February 1942 (an overlap), which produced 2,800 foot-seconds' velocity at only 42,000 pounds' pressure.

Recently a new noncorrosive primer composition has been under study. This will remove the last of the fouling problems which have bothered the shooters for so long—but we still say, "A good rifle is worth cleaning."

Concurrent with development of the ball cartridge there were many special-purpose loads. At first there was a special blank for Gatling machine guns. These (Fig. 2) had the case extended to form the shape of a bullet so as to feed through the Accles magazine. The regular blank used a hollow dummy bullet made of paper, similar to those used in the Krag blank. There was a guard cartridge having a light load and identified by five rings around the center of the case. A dummy round for training had six longitudinal grooves in the tinned case and holes drilled through it.

Test cartridges were tinned and had the words "TEST" or "HP TEST" on the base. Later the special headstamp was omitted because the standard case was found to be strong enough, and the tin coating was considered sufficient identification.

Some changes were made in 1909. A new blank eliminated the hollow paper bullet, which had been needed to contain part of the powder charge. Using EC powder, less was required, so the case was closed by an inverted paper cup inserted into the neck with shellac. A new guard cartridge (Fig. 2) had dents around the case shoulder to identify it.

With World War I came a need for other special-purpose cartridges. We had experimented with armor piercers and tracers from about 1910, but the first official series was that of 1917. It included incendiary, flat-nosed and filled with white phosphorus; AP having an exposed lead nose-filler; and tracer which had a tiny cannelure near the bullet tip. There was also a new dummy without flutes—omitted to save an operation during the emergency.

IN 1918 there was a new group which included an AP with full jacket identified by a light cannelure near the bullet base, a tracer with dark-stained case, and a "spotlight" cartridge for target designation. It had some incidental explosive and incendiary effect. There was a special blank for the "VB" grenade that we adopted from the French. This had a wooden bullet which passed through the grenade body and tripped the fuse mechanism.

The M1917 AP had been an effective cartridge. Its exposed lead tip gripped the armor plate and kept the bullet from glancing off. But the Germans claimed it illegal, based on an international agreement outlawing the so-called dumdum type. Fearing reprisals, Ordnance introduced the new 1918 design. Shortly thereafter, the Central Powers started using bullets similar to our M1917.

In 1918 Frankford Arsenal began to study the use of steel for cartridge cases. Some were made, but the process was not perfected.

There have been other odd rounds, such as the M1919 gallery cartridge which had a 135-grain bullet and reduced load for indoor target shooting. The M1921 range dummy resembles the ball round exactly save for being inert and having a slot in its head for identification. The coach uses this for range instruction so that the pupil cannot tell if the round being loaded is live or not.

BETWEEN the two World Wars Ordnance introduced many new variations of AP, tracer, incendiaries, and combinations of them, each identified by a color applied to the bullet tip. The armor-piercing bullets at first contained tungsten cores; though this was a strategic material, likely to be scarce in wartime, its use seemed required. Finally techniques were perfected which permitted more readily available steel alloys to be used with excellent results.

A new dummy cartridge was made, reverting to the fluted case, but without the holes. Special grenade blanks came and went, and a frangible bullet for aircraft gunner training joined the family. The ball cartridge, however, remains essentially about as it was originally—still capable of fine accuracy.

During all this time Frankford Arsenal and the ammunition industry never stood still. Continual refinement of process and improvement of quality was the rule. The number of draws needed to form the cartridge case has been reduced from seven to four. Actually they can be made in only two draws, but this is considered an emergency measure, as the metal is severely stressed.

Performance has been improved by new heat-treating and annealing techniques. Machines have been simplified and made automatic as much as possible. Tooling and gaging have been perfected, so that today our methods are being used in many countries all over the world.

Interest in steel cases was revived during World War II and again during the Korean campaign. Many were made meeting most of the requirements, but a few refinements remained to be worked out. Finish, lubrication during processing, and heat treatment all need the experience derived from large-quantity production in order to correct the last few "bugs." In order to really pay off, we must be able to handle the sort of low-quality steel we would have to use in a national emergency.

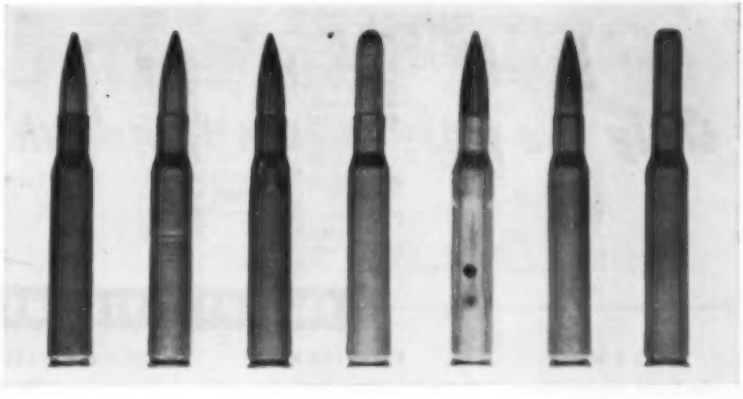
While the ammunition was developed and improved there were many persons who made significant contributions to the job. Col. Glenn P. Wilhelm was one of the early torchbearers, followed by Col. W. L. Clay, Col. George A. Miller, Jr., Frank Jervey, Langhorne D. Lewis, Arthur Darby, Patrick Riley, Edward Moyer, Walter Keller, John Mathews, and many others.

THERE were some whose main field was weapons, but who helped a lot with the ammunition problems. The outstanding member of this clan was Maj. Gen. Julian L. Hatcher.

Colonel Wilhelm was involved in the ballistic tests of small-arms ammunition. He built this department up from scratch at Frankford, Sandy Hook, and finally at Aberdeen Proving Ground.

All in all, it has been a grand job on the .30-06! May the newcomers in the cartridge family look as good fifty years from now!

Fig. 2. Original series, caliber .30 1906 cartridges, left to right: Ball; guard; guard M1909; blank; dummy; test (plated); blank, Gatling.



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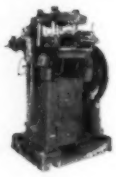

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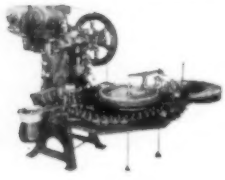

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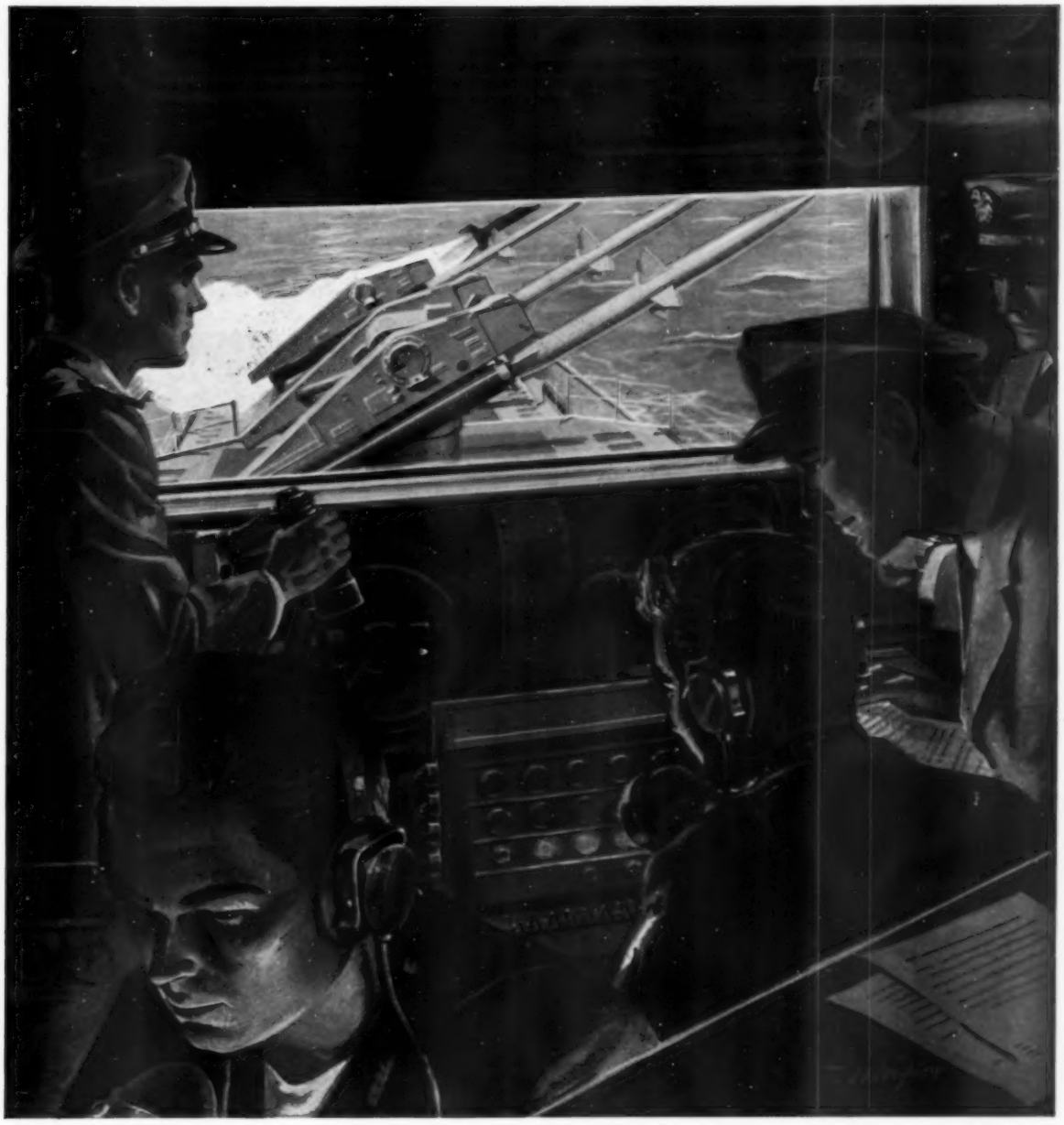

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